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The Detection of Adulteration in Food.

BY C. M. VORCE.

I. COFFEE.

At the present day there is scarcely any article of food which undergoes any sort of preparation before being sold for consumption, that is not habitually adulterated, either by the manufacturers or the dealers, although most articles can be obtained pure by special effort and at an advanced cost. In the detection of adulteration, probably no means is so generally and readily applicable as microscopical examination. In many cases chemical analysis is more certain and positive as to the true nature of the adulteration, but it is so much less readily applied, that for common purposes it may be left out of consideration, save in special cases. But there is another method of examination which should not be neglected, that is, physical examination.

One of the commonest articles of daily consumption by all classes is coffee. This can be obtained pure, but in consequence of the great convenience of buying it ground and ready for use, it is largely sold in this form; and, in most cases, when thus sold, it is adulterated. It is the popular belief that coffee, when adulterated, contains chicory; but aside from this fact, chicory itself as imported, is often, if not, indeed, usually, adulterated. A common article of adulteration is roasted peas. There is a two-fold reason for this, since peas are not only cheaper, but also heavier than chicory.

In the adulteration of chicory many kinds of roots are used, but if they possess a strong flavor, it must be neutralized or disguised; if the roots employed be white or light-colored, they must also be dyed to imitate the color of coffee, which is darker than chicory. In the majority of cases it will be found that both chicory and peas are used in the adulteration; and in some very cheap samples no coffee at all will be found.

To detect adulteration of any substance, the first requisite is to know exactly what we ought to find in the genuine, pure article. A pure sample of coffee can be obtained by buying it in the berry, and having it ground on the spot, as is the custom in many stores, or by grinding it at home; but a better way is to take a few of the roasted berries and see just what they are made of. First, cut one across with a fine saw; when this is done, we find the berry to be rolled upon itself, thus:  the cavity which extends nearly the whole length of the berry is lined with a fine, thin, beautifully marked membrane, composed of fusiform, pitted cells (Fig. 1), which, when the berry

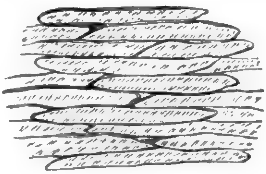

FIG. 1. Membrane of Coffee-berry.

was in the seed-pod, was continuous over the whole surface of the berry, but which, in the process of separating the berry from the shells has been removed from the outside and is

now only found in the shelter of this protecting cleft. By splitting off with a knife the outside of the berry, as much of this membrane as remains can be removed entire, and if mounted, it is a beautiful object.

We can now form some opinion as to what proportion of the whole bulk of the berry this membrane forms; and about the same proportion should be in the ground article.

In examining the ground coffee microscopically, after examining the sifted part for starch, etc., it is sufficient to shave off little slices from the larger particles with a razor or sharp knife, and examine them in water or turpentine under the microscope, with a one-inch, one-half-inch, and a one-quarter-inch objective. The indications afforded by the other tests will be thus very readily confirmed, so far as to decide whether the coffee is adulterated or pure.

By cutting a slice from one-half of the berry, and grinding this down thin, just as we would grind bone, or by shaving off, with a razor, little flakes from all portions, we shall find that aside from the membrane, the coffee-berry consists wholly of regularly arranged cells, very uniform in size, containing a reddish-brown, oily looking substance (Fig. 2),

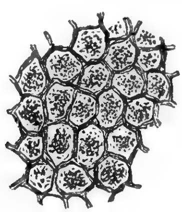

FIG. 2. Cells of Coffee-berry.

and the appearance of the cells and their contents is similar through all parts of the berry, but near the surface they are somewhat compressed. When once familiar with the appearance of the coffee-cells, they cannot be mistaken, and we now know just what we ought to find in pure ground coffee. On examining a sample of ground coffee known to be pure, we find it is all of a uniform brown color, the smell is characteristic and easily recognized, and not like that of any other substance. On rubbing it between the finger and thumb, it is found to be hard, brittle, not in the least sticky, and it does not stain the fingers; white paper is hardly soiled by rubbing ground coffee upon it; the larger particles cannot be crushed under a knife-blade, and on putting some into water, it stains the fluid very slowly, but throughout; the particles are too hard to be crushed under the thumb-nail, even after lying in water for a week, and they are scarcely swelled at all in cold water.

If chicory be present in a sample of coffee, it will be found in pieces larger than the smaller particles of coffee—it will be lighter in color, and if in considerable proportion, its peculiar sweetish odor will be distinguishable. The particles will feel spongy, like chips of cork, and can be flattened down, under a knife-blade, like gum. In water, chicory yields its coloring-matter very quickly, but the color remains in the lower portion of the fluid unless shaken, and the particles swell very quickly, doubling their bulk in half an hour. By soaking it for about six hours, the particles of chicory will be found soft and mushy; and by putting one on a

FIG. 3. Cells of Chicory.

slide under a cover, it can be pressed out into an extremely thin film, and the large cells of chicory will be seen in long strings (Fig. 3), with occasional fragments of spiral tissue; each cell of chicory, at this stage, is about twenty times the size of coffee-cells, treated in the same way.

If peas or beans were used in adulterating the sample under examination, their color, if well-roasted, will very closely resemble that of coffee, and the particles will be hard, but will crumble by rubbing between finger and thumb, and will also crush under the knife-blade. Their odor is but faint and hardly to be noticed in the stronger odor of the coffee. The starch-grains and cells of the bean or pea, and the fragments of the outer membrane, composed of very fine columnar cells, will be found and distinguished at the first glance from coffee-cells, which they do not in the least resemble. In water, both beans and peas swell quickly, but more slowly than chicory, and soon become soft, so as to be readily crushed down.

It would extend this article to too great a length to consider, separately, all the roots and seeds that can be and have been used, to adulterate coffee. Starch is present in all the grains—corn, rye, wheat, etc., that could be used, and spiral tissues in all the roots, so that the fact of adulteration is very easily and certainly determined by the microscope, although the determination of the precise substance used is somewhat more difficult. The livers of animals chopped, dried and ground, have been used to adulterate coffee, but this material is not probably used at this time, and, like the coffee-berries made of dried and colored clay, of which we have read, probably could not now be found in any manufactory or store.

To examine ground coffee, it is best to sift it and examine first the fine particles, and if any starch-bearing adulteration is present, starch will be found. Next, examine pieces selected from the larger particles, and if any pieces of roots are present, here they will be found. Any pieces of tissue or membrane noticed, should also be inspected, and will disclose the presence of seeds like beans, etc. Then place about a teaspoonful of the sample in a two-ounce vial of water, and note the results as before indicated.

To enable a person to pronounce certainly on all substances used in adulteration requires protracted research, for which considerable time and a vast amount of labor are necessary. Thus, the mere finding of starch in a substance not naturally containing starch, will not enable an investigator to pronounce, with certainty, what kind of starch it is, unless he has examined every kind of starch-bearing substance, which, of itself, would be the labor probably of years. But to determine whether any adulteration exists, is a much simpler matter, and in a succeeding article the examination of other substances subject to adulteration will be considered.

If it is desired to mount for permanent preservation a pure sample of coffee, or even an adulterated one, or samples of the ingredients used in the adulteration, it may be done either in balsam or glycerin. To mount in balsam, take the fine, sifted part and steep it in turpentine or chloroform until the air in the cells is expelled, when, after shaking it, take by a pipette from the bottom that which first settles, and mount in balsam in the usual way. For glycerin-jelly mounting use alcohol instead of turpentine. Samples of the foreign ingredients may be mounted in the same way, or by mounting the small slices cut for examination. It would be useful also to mount samples which have been subjected to maceration, when they can be crushed down into a film, and mounted in glycerin or glycerin-jelly, so as to better exhibit the shape of the individual cells and their arrangement,

and to serve for comparison with other samples undergoing examination after maceration.

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Infusoria upon Leaves.

In reference to the brief notice of Saville Kent's work on the Infusoria, which appeared in the last issue of this JOURNAL, Mr. J. Sullivant writes as follows: "I would like to hear more of the germs of Infusoria on blades of corn to which you allude. Does it not account, in some measure, for the readiness with which certain Infusoria make their appearance in hay-tea and other vegetable infusions?" Mr. Kent replies to this question in a very interesting manner. Besides the organisms which are commonly said to develope in hay-infusions, which belong to the genera *Paramecium*, *Colpoda*, *Cyclidium*, *Oxytricha* and *Vorticella*, he finds a host of others, when the infusions are watched from day to day, among which are *Heteromita* (*Monas*) *lens*, *H. caudata*, *H. gracilis*, *Okomonas*, *Dinomonas*, *Rhabdomonas*, *Monas* proper, *Cryptomonas*, and other flagellates, while Bacteria are always present. Mr. Kent has "positively ascertained," that at least some of these minute beings, "are derived from spores which literally encrust with their countless numbers the stalks and blades of the vegetable matter; these again being the product of preëxisting monad forms, whose active life was passed in close association with the green and growing hay under the circumstances hereafter narrated." The experiments which were carried out to elucidate this subject are briefly described. We can only indicate the method of investigation, in the hope that it will lead others to contribute further information on the subject. Hay from different localities was macerated in water which had been previously boiled for some time. From the first wetting and simultaneous examination of any given sample, countless numbers of spores were found, most of them excessively minute, averaging about $\frac{1}{20,000}$ of an inch in diameter.

In the course of six hours the hitherto motionless spores were observed detached, they exhibited a vibratory movement, and seemed to resemble in all ways, the members of the uniflagellate genus *Monas*. A large proportion of these spores were at first united in clusters, so as to form floating, necklace-like aggregations. After a while they separate and each maintains an independent existence. They then increase in size, and in twenty-four hours measure $\frac{1}{3000}$ to $\frac{1}{2500}$ of an inch and possess two flagella. They then possess the characteristics of *Heteromita*.

It appears that the entire life-cycle of the Infusoria thus found is passed in connection with the plants, and that the spores do not come from the air. They are most abundant upon the lower blades which indicate by their brown or yellow color the progress of decay, where they find a plentiful banquet set for them. Their purpose in life "is to break down and convert into new protoplasmic matter this otherwise waste product;" but to prevent the too rapid increase of these herbivorous species, there are other types, which answer to the carnivora among them, such as *Dinomonas* and various ciliata.

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Mounting With Glycerin-jelly.

Glycerin-jelly has long been known as a mounting medium, but most persons have found some difficulty in its use. The precipitation of balsam by all watery objects, especially aquatic insects and fresh-water algæ, induced me to devise the following mode of manipulation, by which glycerin-jelly may be used with great rapidity, avoiding the tedious preliminary preparation necessary for balsam. The jelly is made by dissolving transparent isinglass in sufficient water, so that it makes a stiff jelly when at the ordinary working temperature of the

room where the slides are mounted, add one-tenth as much good glycerin and a little solution of borax, carbolic acid, or camphor-water; salicylic acid is a good preservative, but I have thought that it might dissolve some preparations. The mixture should be well filtered, while hot, through washed muslin or other fabric, as it will not run through the usual filter-paper, and the subsequent addition of a little alcohol improves its working. Objects, if perfectly clean, may be transferred at once from water to this medium, which should be slightly warmed before using if not perfectly fluid. The cover is adjusted and the slide put away until a number have accumulated. The cover should not be pressed down too hard, and a liberal amount of jelly used to allow for shrinkage in drying. The slides may be finished as soon as the jelly has set, or they may be left for several days. If air-bubbles are entangled they will usually escape while drying, or they may be driven out by warming the slide a little. When ready to finish the slides, take them to a water-cooler and let the ice-cold water drip over them, while with a camel's hair brush, rather stiff, all the superfluous jelly may be readily brushed away by the aid of the flowing water, which keeps the jelly under the cover, hard. The slides are then dried with a towel or blotter, and finished with a balsam-ring, or with any other cement that suits the fancy of the operator.

The advantages of this method are that it obviates the necessity of the previous preparation of cells for objects of considerable thickness, and it seems to present most of the advantages of a fluid-mount without its difficulties. If the slide is properly dried before finishing with balsam, no cloudiness appears, and the slide cannot be distinguished by inspection from a balsam-mount, while there is much less distortion, loss of color, etc., in the jelly than in the balsam solutions usually employed. I have found no reason in ten year's experience to doubt that slides mounted in this way will be permanent.

W. H. Seaman.

Cells—Their Growth and Functions.*

Every member of the Society is, in a general way, aware that all living organisms from the simplest to the most complex, are developed from simple cells, but perhaps it would puzzle some of us to tell just what a cell is, and precisely how it grows and multiplies. Still, some knowledge of the growth and functions of cells is necessary, if one desires to understand the simplest phenomena of plant or animal physiology, and even structural botany only becomes a part of scientific study when we consider the gradual changes which the simple cells undergo, as plants develop.

It is my intention to bring before this Society, from time to time, short papers describing the various methods by which cells multiply and change their forms and functions. The subject is one which possesses great interest to the general microscopist, and so far as time permits me, I shall endeavor to make the papers intelligible to those who have not studied cell-growth and also interesting to those who have.

The word cell, in the language of science, has a number of synonyms, among which may be mentioned *utricle*, *vescicle*, *corticula* and *cellule*. At the present time all of these, except cellule, are obsolete, and we speak of cells or cellules synonymously.

A complete cell is composed of four parts, viz.: the cell-wall, the protoplasm, the cell-sap and the nucleus with its nucleolus. Usually, however, the term cell is employed in a very general sense, to designate the elemental structure of plants or animals, without reference to the presence of

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* Read before the New York Microscopical Society, December 3d, 1880.

nucleus, protoplasm, or even cell-wall. In the exact language of science, I think the word should be restricted to a structure with cell-wall, protoplasm and nucleus. Häckel, in his admirable nomenclature, has distinguished between a cell, which has a nucleus, and a "cytode," which is the same structure without a nucleus.

However, while I would like to give a definite meaning to the word cell in these papers, I am unable to find another word which will convey just the same comprehensive idea of structure, so I must be content to use the word in its very general sense, applying it to structures which may be either living or dead; and when a more restricted meaning is intended to apply to a living cell with nucleus, protoplasm and cell-wall, the term complete cell will be employed.

THE CELL-WALL is composed of cellulose. In living cells, when the membrane is very thin, it can be brought into view by causing the fluid contents of the cells to retract from the wall, by allowing a drop of a solution of sugar to flow under the cover-glass.

Cellulose can be readily detected in the cell-walls by several chemical tests, the best of which is based upon the fact that it is colored blue by iodine, after it has been subjected to the action of certain dehydrating agents, as sulphuric acid or zincic chloride. In applying this test, in any form, it is quite necessary that no excessive quantity of water should be present, for the water would probably dilute the reagent so much that it would not act in a satisfactory manner. The reaction may be obtained in several ways, but the best method is that of Vétillart, which may be briefly given as follows:—

1. Mix $10^{c.c.}$ of strong glycerin with $5^{c.c.}$ of water, in a flask, place the flask in cold water and add, slowly, with constant stirring, $15^{c.c.}$ of sulphuric acid (of 66°). This mixture slowly loses its strength, but it can be easily restored by the addition of a little strong sulphuric acid.

2. Dissolve 5 grms. of potassium iodide in $50^{c.c.}$ of water.

First treat the specimen to be tested by boiling in a solution of 10 parts of sodic carbonate in 100 parts of water, then wash out the soda with water, then remove the water as completely as possible by means of blotting paper. Treat now with iodine solution until the tissues are fully impregnated with it, and draw off the excess of the fluid, as before. Then add a few drops of the solution of sulphuric acid. The pure, unaltered cellulose soon becomes colored blue, and where the cell-walls have become changed or lignified, the color is more of a yellowish tint. However, even when the cell-walls have become much thickened and altered, it will be possible to detect the blue color in a thin, inner layer next to the protoplasm.

The author of this process considers that the boiling in the soda-solution should not be omitted in doubtful cases. It seems to cause a swelling of the tissues and makes them more permeable to the reagents. Some authors recommend, as a substitute for the carbonate, a concentrated solution of caustic potash or soda, with which the specimens should be treated for a few seconds only, but the general employment of such powerful reagents is not to be advised. It is claimed, however, that the blue reaction has been obtained in certain tissues after treating them with caustic alkalies, while they failed to give the result when the carbonate was used. It should be observed that the blue color is not permanent—it soon disappears. In my own experience I have found no difficulty in obtaining a good blue coloration without the use of any alkaline solution, but there is no doubt that it is always best to carry out the directions of Mr. Vétillart. In my hands a concentrated solution of zincic chloride, containing a little potassic iodide and iodine has invariably

given excellent results, without any preliminary treatment.

Cellulose dissolves quite readily in an ammoniacal solution of cupric oxide.

The action of reagents upon the cellulose-walls of cells, is often greatly influenced by the changes which they undergo during the processes of growth. It is not the proper place here to consider this subject, but it will be fully discussed when we have to study the growth of the cell-walls more particularly. It is a matter of great importance in the examination of textile fabrics.

Elder-pith and fibres of cotton afford excellent specimens for the study of cellulose.

PROTOPLASM is the name which has been given to the syrupy or gelatinous portion of living cells. Young cells are filled with it, but as they grow older the sap begins to form, first appearing as cavities or vacuoles in the protoplasm, soon the protoplasm spreads over the inner face of the cell-wall, leaving the more fluid sap within.

Often the nucleus of the cell is supended in the centre by means of threads of protoplasm, which extend from the outer layer across the cavity which is filled with the sap. This arrangement is beautifully shown by some species of *Spirogyra*, and has already been demonstrated before this Society. The layer of protoplasm is often quite distinctly visible under the microscope, as in the cells of *Nitella*, *Anacharis* and *Vallisneria*, but more frequently it is very thin and delicate. It can always be demonstrated by treating the cells with dilute acids, alkalies, or a solution of sugar in water, which will cause the protoplasm to retract from the cell-wall.

The exact composition of protoplasm is very difficult to determine; it is a constituent of every living cell and its characters seem to be the same in both the animal and the vegetable kingdoms. From the protoplasm the other cell-contents, chlorophyl, cell-sap, starch grains, and the cellulose-wall itself, are elaborated.

The distinctive characters of protoplasm are well shown in such plants as *Nitella* and *Anacharis*, in which the phenomenon of cyclosis is so distinctly visible. It appears as a semi-fluid mass, constantly moving around on the inner face of the cell-wall. Certain other plants show a different motion of the protoplasm, which is known as circulation. In these plants the movement of the protoplasm takes place in the form of currents running in various directions. Circulation may be seen in *Œthalium septicum*.

Protoplasm is often found in a free or naked condition, in considerable quantity, and we are, therefore, enabled to study it more advantageously than would be possible if it could not exist without a cell-wall. Many of the algæ propagate by means of swarm-spores, which are spherical masses of protoplasm colored with chlorophyll, quite destitute of any cellulose membrane. Then we have the Amœba, the white blood-corpuscle and the so-called plasmodium of certain fungi belonging to the Myxomycetes, which manifest the phenomena of extension, retraction and growth, which are the distinguishing characters of protoplasm. The plasmodium is a mass of protoplasm from which the fungi develop; it is common on rotting wood in moist situations, in swamps and along shores of streams, where it forms gelatinous masses of considerable extent. In this the amœboid movements of protoplasm are well manifested.

The CELL-NUCLEUS is a spherical or ovoid, clear or granulous particle which is often quite distinct. It may be suspended in the middle of the cell by means of protoplasmic threads, stretching from the protoplasmic utricle, as already mentioned, or it may be imbedded in the layer of protoplasm, and be carried around with it in the cyclosis. Sometimes the nucleus is very large, as in certain cells

in the leaf of *Iris pumila;* in other cases it is very minute and sometimes cannot be found. Some writers assert that every cell must possess a nucleus during some stage of its growth, but others are inclined to doubt this. We know but very little about nuclei, and until we have learned much more about their nature and functions, it seems rash to declare that they are essential to the development of a cell; for we know that in some instances the nucleus does not appear to take any active part in the process of cell-division or multiplication. Still I think it is quite probable that the nucleus always is active when cells undergo division, and it appears, from late researches, that nuclei are present in many cells which have been previously considered to be destitute of them. Owing to the amount of coloring matter in many cells which renders it quite difficult to study the cell-contents to advantage, we are often obliged to resort to reagents before we can detect the nuclei. The reagents most commonly used are such as will stain the nuclei and leave the other structures uncolored. I have succeeded best with a neutral solution of carmine, but many other staining fluids have been recommended from time to time. It is not positively known why the nuclei will absorb a color and retain it while the other parts of the cell remained uncolored. In the case of animal-cells it has been suggested that the nuclei possess a slightly acid property after death, which decomposes the ammoniacal carmine solution and causes the carmine to deposit in them. However, this is purely an hypothesis, and perhaps an unnecessary one, for nuclei become deeply colored by other dyes than carmine. It appears that they cannot be colored while living, hence the usual course is to kill them first, by plunging the tissue into alcohol, and then applying the staining fluid.

It is thought that nuclei are portions of protoplasm which have become condensed. Whatever may be their composition or origin, any one who observes them carefully and under favorable conditions, cannot fail to have the conviction forced upon him that they are of great importance to cells which contain them. There is often a radiate arrangement of the protoplasm about the nucleus, particularly at certain stages of growth, which is quite striking.

I wish to add a few words about the application of reagents in the study of nuclei. From a chance observation which I made during the Summer of this year, I am inclined to think that very misleading results may be obtained as to the form and position of nuclei, if they are not examined in the living state within the cells. I was applying some reagent to an alga, under the microscope, and just as the fluid reached the cell which was under observation, the nucleus changed its form and appearance to such an extent that I was convinced that the only way to be sure of accuracy in this kind of work was to examine the living cells. Nevertheless, the use of certain fluids is necessary in the study of cell-growth—absolute alcohol is one of the most valuable—and when the nuclei are very minute, as in some of the uni-cellular algæ, it is necessary to stain them before they can be discovered.

As my attention will be particularly directed to the functions of nuclei in the cell of algæ, I hope to have more to say about this subject before the close of the year.

The next paper that I intend to present will treat of the processes of cell-division.

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A New Method of Bleaching and Washing Sections.

Microscopists are indebted to Sylvester Marsh, for the following excellent process, the description of which first appeared in the *English Mechanic.*

Two wide-mouthed bottles, each of about two ounces capacity, are procured. Corks are fitted to them and the corks are connected by a short piece of glass tubing which is bent at each end, and passes down through the corks, passing just through one cork and far enough through the other so as to almost touch the bottom of the bottle when the cork is inserted. A channel is to be made in the side of the cork carrying the long arm of the tube, and one of the bottles is then filled about three quarters full of filtered rain-water, and in this the sections to be bleached are placed. In the other bottle a sufficient quantity of chlorate of potash in crystals is placed to just cover the bottom, and then a drachm or so of strong hydrochloric acid is poured upon them. The corks are then placed in the bottles, being particular to put the cork carrying the long arm of the tube in the bottle containing the sections. The yellow vapor of chlorine (or, rather, of euchlorine), immediately begins to be evolved and passes over through the tube into the water containing the sections. When the water becomes saturated with chlorine, the excess rises and escapes through the channel in the cork. It is Mr. Marsh's practice to arrange the apparatus for work at night and to set it out of doors in a covered place, in order to avoid annoyance from the escaping fumes of chlorine.

To wash the sections after bleaching, a bottle is taken, similar to the others, but having a small aperture filed in the side at the shoulder. The bleached sections are placed in the bottle and covered with filtered water. A small funnel is then fitted to the cork, and the neck of the funnel is continued to the bottom of the bottle by a piece of fine rubber-tubing, the tube being carried to the side of the bottle opposite the aperture. A sheet of filtering paper being placed in the funnel, the bottle is placed beneath a water tap and a gentle stream of water allowed to trickle into the funnel continuously. A constant circulation of water is thus maintained in the bottle, the discharge being through the orifice in the side. As in the case of the bleaching the apparatus is set to work at night, and in the morning the sections will be found to be thoroughly washed.

The advantages claimed by Mr. Marsh for this method are that the sections are effectually bleached without being subjected to the destructive and disintegrating action of the chlorinated soda solution; neither will the sections suffer from the deposit upon them of a scum of carbonate of lime, as frequently happens in the use of the ordinary bleaching fluids. The apparatus is easily constructed and the results are very satisfactory.

A. L. Woodward.

The Preparation and Mounting of Microscopic Objects.

IV. In the preceding articles upon this subject, we have considered "Cements and Apparatus," "Dry Mounting," and "Mounting in Fluid." There is still another method of mounting which is more generally employed than any other, viz.: mounting in balsam. There are several methods of preparing balsam-mounts, and the microscopist is governed in his selection by the character of the object. A few hints upon this subject will be found in the course of this article.

Mounting in Balsam. The object of mounting in Canada-balsam is to render the objects clear and transparent. It can readily be understood that by filling the pores of an object with a highly refracting medium, that object will become transparent, for the same reason that a piece of paper is rendered clearer when a drop of oil is applied to it. To decide whether an object should be mounted in balsam or in some other medium, it should be subjected to a preliminary examination in water and in turpentine, and if it looks better in the tur-

pentine it should be mounted in balsam. An object that is to be mounted in balsam must be free from any trace of water, for water and balsam do not mix. If the object has a tendency to retain air within its pores it will be necessary to replace the air with some fluid which will mix with balsam, before proceeding to add the latter medium, otherwise the air-bubbles will appear as dark spots in the mount. The fluid usually employed for this purpose is spirits of turpentine ; in fact, it may be laid down as a general rule that any object that is to be mounted in pure balsam should first be freed from water and then thoroughly permeated by turpentine, after which the balsam may be applied. Some objects may be dried, placed for a few moments in turpentine and then mounted in balsam, but there are many others which cannot be dried without distortion, and others which, when once dried, retain the air so tenaciously that it is almost impossible to remove it. In such cases one has to resort to some other process for the removal of the water. This is readily done as follows : Place the object in alcohol for a short time, then transfer it to absolute alcohol and then to the turpentine. When an already dry object retains air, place it in turpentine and boil it a number of times. From turpentine the object should be transferred to the slide, a drop of balsam added, and the slide warmed until the balsam flows and penetrates the object. The cover-glass is then applied, and if necessary this is held in place by means of spring clips. The mount is then dried slowly, either in a drying oven, over a stove, or on the brass mounting plate. The writer usually follows the above process, using the ordinary balsam of the shops, which has become somewhat hardened by long keeping. In this matter his practice is somewhat at variance from that of a large number of the best mounters, for the process which is described below, owing to the rapidity with which it can be conducted, is in great favor.

However, the above process possesses certain advantages over any other, which the beginner will not be slow to appreciate ; for in case a few minute air-bubbles are left under the cover, they will be absorbed by the balsam, and in mounting certain diatoms, from which it is difficult to remove the air, it will be found that pure balsam will absorb every trace of it in a short time. Moreover, it is possible to finish a slide in a few minutes by hardening the balsam over a spirit-lamp, but care must be exercised not to heat too much, or the balsam will turn yellow. When the balsam is sufficiently hardened, it can be readily scraped off from around the cover by a knife-blade, and the last traces cleaned off by means of a cloth dipped in turpentine, alcohol or ammonia. The mount is then finished and ready to be labelled.

Mounting in Dissolved Balsam. The benzole-balsam (Vol. I, p. 65), is most useful for this purpose, but the other solutions are also employed. To mount in this medium it is best to substitute benzole for turpentine, but otherwise the process is conducted in the same manner as described above. The only difference is in the application of the balsam which is quite thin, and must therefore be used in larger quantity. When the cover is applied heat gently until bubbles appear, and in a few minutes the balsam will be hardened so that the slide may be cleaned. A balsam-mount is greatly improved in appearance if the edge of the cover-glass is covered with a ring of benzole-balsam, applied on the turn-table. Some special processes will be given next month.

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Extract from "Le Microscope."

BY H. PH. ADAN.

Published in Brussels : 1873.

[We are indebted to Mr. Charles Stodder for the following interesting

extract. It is not very old, but who doubts to-day the possibility of resolving *A. pellucida?*—Ed.]

Yes, you have under your eyes the despair of microscopic amateurs, the illustrious, *Amphipleura pellucida*. At first sight, this corpuscle seems quite insignificant, but one should know, that upon these little elongated valves, terminated with double ended extremities, and showing a separating line in the middle, there are horizontal striæ of an unheard of fineness, to such a degree even that most micrographers deny absolutely their existence. And truly, the most powerful apparatus of mine had failed to show them to me, until one fine day I succeeded in obtaining the one-fifth inch objective of the celebrated American constructor Tolles. These lenses have the reputation of being endowed with a force of penetration (resolution ?) and definition unparalleled, so, profiting by the first white clouds which showed themselves on the horizon, I made an essay, and judge of my surprise, when thus, without difficulty, I was able to distinguish perfectly these phenomenal striæ whose existence has been so controverted.

Doctor Hartnack laughed till the hot tears ran down his cheeks, when I told him of this discovery; he said I was the dupe of my imagination, that I saw with the eye of faith, and that there were no more striæ there than upon his hand.

I renewed the observation under identical conditions and always with the same results. I could no longer doubt. It was a great consolation to me when Dr. Woodward announced, *M. M. J.*, September, 1871, that he had made the same discovery, and with the same one-fifth inch of Tolles.

It remains now to be explained how an objective attaining at its maximum an enlargement of 200 (300 ?) diameters only, can bring out details of what another, ten to fifteen times more powerful, cannot give the slightest idea. Of all the problems of the microscope, this is the most difficult to resolve. Doubt can then no longer be permitted, and Dr. Hartnack will have his fine laugh and will be forced to yield to the evidence, and make the *amende honorable*.

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Studies of Atmospheric Dust.

A long summary of the researches of M. Pierre Miquel on the "Organized Dust of the Atmosphere" has been running through several numbers of *Brebissonia*. The second part begins with a consideration of the "Schizophytes of the Atmosphere," and since many workers with the microscope find great difficulty in distinguishing between Bacteria, Vibriones, Spirillæ, etc., the following free translation from this portion of the paper may be of use to them.

In his last memoir on the Schizophytes, M. Cohn has given a botanical classification of bacteria and vibriones. The classification published by this German savant includes no less than fifty species and several hundred varieties. The atmosphere, which may on certain occasions, become the vehicle of all these organisms is, however, far from presenting to analysis the great number of various forms which multiply in exposed infusions. There are spores of bacteria and also of moulds; certain of them are constantly presented to the eyes of the observer. The liquids which are sown with dust from several litres of air rarely become peopled with organisms of greatly varied forms; almost always one finds *Micrococcus* and *Bacillus*, which seem to have a mission to mask the microbes which one desires to discover among the particles of dust carried by the wind. To enter upon the study of the bacteria of the atmosphere, therefore, it is not necessary

to know, in its lesser details the premature classification of M. Cohn; it suffices to refer to certain genera respectively the cellules and the rods which are most frequently found. Among these are the micrococci, bacteria, leptothrix and vibriones. To avoid all misunderstanding, we briefly describe these genera, and name the varieties that are there most frequently found.

Micrococcus, Hallier.—This name is given to a number of minute spherical or oval cellules, motionless, isolated or in couples, sometimes serially disposed like a string of beads. The colored micrococci or Chromogenes, studied by Professor Cohn, possess no special physiological interest, while those studied by M. Pasteur are, in this connection, quite remarkable; of these may be cited the *M. urea*, the acetic ferment (*Mycoderma aceti*), and the viscous ferment. According to Hallier, the pathological micrococci are quite numerous; however, up to this time their existence is regarded as hypothetical by the most authoritative savants, De Bary, Hoffman, and Cohn himself, who, nevertheless, admits the existence of the micrococci of vaccine, of diptheria and of septicemia.

Bacterium, Dujardin. — This genus is restricted to motile forms of cells, longer than broad, isolated or united in twos, fours, and rarely in larger numbers. The true bacteria differ from the bacilli by their short articulations, and from micrococci by their movement. These characters are, indeed, of little help to the microscopist who is called upon to determine the genus of a microbe by a simple examination. Often, in fact, at low temperatures and in media poor in oxygen and plastic materials, the bacilli greatly resemble bacteria. Schröter has described some chromogene bacteria, Ehrenberg the *Bacterium termo* and *punctum*, Dujardin the *B. catenula*, finally Warming three or four other varieties.

Bacillus, Cohn. — Among the species placed in this group are all the motile or motionless organisms in the form of rigid rods, long and short, large and small, disposed in chains of one, two, three or more articles; one is naturally led to place in this category all bacteria of considerable length.

Among the more remarkable bacilli should be cited *Bacillus anthracis*, discovered by Dr. Davaine, and which was recently the object of researches by MM. Pasteur and Joubert; the butyric ferment of Pasteur, one of the most singular of the rod-like forms; the lactic bacillum, and some others of wine and silk-worm maladies.

The *Bacillus amylobacter*, studied by MM. Trecul and Van Tieghem, which has been classed as a distinct species, according to the recent work of Van Tieghem, is merely the butyric ferment; from which it results that the same organism possesses the power of transforming calcic lactate into the butyrate (Pasteur), of causing fermentation of cellulose (Van Tieghem), and of a large number of other substances, with a disengagement of hydrogen. If one adds to these facts, that the butyric ferment of Pasteur lives and develops in the absence of the oxygen of the air, one will understand the importance attached to a perfect knowledge of many fermentations, of which this organism may be the primal cause. Dr. Davaine has described several bacilli of putrefaction, the physiological functions of which are less perfectly known.

Finally, Cohn has given the name *Bacillus subtilis* to a rod-like or-

ganism, to which it is tacitly agreed to join all the bacilli that are not yet classified, with a laudable desire to avoid confusion.

Leptothrix, Kutzing.—The filaments of leptothrix are long, motionless, not ramifying, without visible partitions, and are not characterized by any physiological function worthy of mention. Ch. Robin has described *Leptothrix buccalis*, which he considers, with reason, may belong to the bacilli.

Vibrio.—The species forming this genus are readily distinguished from those of the preceding; they are always motile, of soft consistence, without rigidity and progress in an undulating manner like eels. Muller has described *Vibrio serpens* and *rugula.* M. Pasteur has published, in a recent memoir, his researches on an anærobic vibrione which may be the cause of septicemia.

There are, besides, microbes very elegant in form, curved like a helix, which have been named spirillæ (*Spirillum, Spirochæte*, Ehr.). One of them, the *Spirochæte Obermeieri*, has been found in the blood of patients suffering from recurrent fevers. Dr. Heydenreich has published a monograph upon this organism. In forty-six cases of recurrent fever, studied with great care by him, the organism discovered by Obermeyer always appeared in the blood during the crisis, to disappear during the remission. Placing the blood of a patient in one of the halls of the hospital, at the ordinary temperature, the doctor has observed the spirillum die at the end of several days, at the temperature of the body it lives only ten or twelve hours, and it dies at the end of four hours at a temperature precisely equal to that of fevers. In consequence of these experiments several persons voluntarily submitted to inoculation with the helix-like organism and became affected with recurrent fever.

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A New Objective.

A correspondent of the *English Mechanic* describes a new oil-immersion of Powell and Lealand, which he states has an aperture of 142° measured in a crown-glass semi-cylinder, having a mean index of refraction of 1.5, nearly. The front lens, which is more than a hemisphere by several degrees, is mounted on a plate of glass .003 of an inch thick; the focal length is .007 of an inch. It is decidedly superior to other objective with which it has been compared.

We would suggest to the writer of the communication referred to, that it is not fair to judge as to the opinions of American microscopists from the vagaries of a few individuals. The fact is, in our opinion, that the microscopists of this country generally hold very sensible opinions about objectives, and it will be a very difficult matter indeed to convince them that there is any advantage in powers of 30,000 diameters and eye-pieces of 1-50 of an inch focal length.

EDITORIAL.

—Two of the articles in this number are printed with the type which was used last year, for the reason that they were already set up for the December number. The JOURNAL has now assumed the appearance which it was our intention to give to it at the beginning, and there will be, so far as the size of the type is concerned, no further change. However, we do not propose to stop here in the improvement of our publication; as soon as the increase of the patronage that has thus far rewarded our

humble efforts will permit, we intend to improve it still more by increasing the number of its pages.

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A HUMBUG AND A NEW SYSTEM OF PHYSICS.—We are quite unable to understand that condition of mind which sometimes leads persons to sacrifice all claims to knowledge and respect, for the sake of ephemeral praise. That a man can deliberately speak and write nonsense for the purpose of obtaining notoriety, seems incredible; and yet, we know that persons do sometimes lay the foundations of a good public reputation as men of science, by just such writing. Usually we are content to let those persons enjoy their undeserved favors, knowing that they will eventually be recognized as impostors; but we have now in mind an instance of a person in this city who has been foisting pseudo-scientific information upon the public for several years, and we deem it but right to express our condemnation of his course. We refer to Mr. Francis Gerry Fairfield, whom the Editor of *Science*, referring to a recent lecture of that gentleman, designated as "a person having an unenviable reputation for making extravagant assertions on scientific questions." The Editor of *Science* also remarked: "We notice that a claim is made that the origin of *Bacteria* and minute forms of life in the atmosphere has been discovered by the lecturer." The utter absurdity of such a claim cannot be discussed in this JOURNAL. If we could afford space for the report of the lecture, as published in the *Herald*, it would doubtless prove amusing to our readers. A still more remarkable effusion from the same source was printed last January, in the *Post*. It was appropriately headed "An Assault upon the Grounds of Evolution," and occupied nearly a column of that paper. We cannot waste any efforts in reviewing the lecture, but as an illustration of the fluent and ambiguous style of the writer, we make room for the following quotation from the report, which was undoubtedly written by Prof. Fairfield himself: "The remainder of Prof. Fairfield's paper rests upon embryological and anatomical researches which cannot be stated in brief, but will fully appear in a monograph now in preparation, the drawings of which with the camera lucida, with the photographing necessary to fullness of illustration, will necessarily take some weeks of severe labor." A year has passed and the "monograph" has not yet appeared—in the interest of science, we hope it never will. Mr. Fairfield is responsible for a number of other articles of a similar character, some of which have appeared in that very ably conducted periodical *The Medical Record*, where we were surprised to find them; but the most wonderful article of all appeared elsewhere, and treats of the structure of blood-corpuscles. A more absurd contribution has never disgraced the pages of a scientific publication. To justify this assertion, it is only necessary to quote the novel principles of physics, upon which the demonstration rests, and which are fully born out by the illustration which accompanies the article.

The Fairfieldian system of physics embraces the following principles, so utterly at variance with the most elementary laws of optics, that it is not only surprising that a man would write them, but that an Editor could be found to publish them: "When a ray of light passes from a refracting medium of lesser into one of greater density, *it enters the latter at right angles to the plane of its surface.* For instance: if a sphere of solid glass is fitted into an aperture in a dark screen, and the light of a gas-jet is directed upon it, *each ray is refracted towards the centre of the sphere, and as all rays meet at that point, a perfect representation of the jet is presented within the ball.*"

This erroneous hypothesis enables Mr. Fairfield to demonstrate that blood-corpuscles are not concave

disks, but spheres; and also to explain the "*luminous spot in the centre*" which is, in fact, a dark spot. This article concludes, with another error, as follows: "With my best glasses and a low light, I have never viewed a corpuscle, old or young, that did not resolve itself into a simple, *globular body*, perfectly transparent, enveloped in a *thin membranous sac, which is the seat of color.*"

Mr. Fairfield's "new high power lens" has already made him ridiculous among men of science, although he still presses his claims for its wonderful excellence. Messrs. Tolles, Spencer and Zeiss might as well give up business, if all that is asserted of the new lens is true. It is clear, from the above lucid explanation of the physics of the microscope, that angular aperture must be a delusion.

We have read a number of articles from Mr. Fairfield's pen, and we do not hesitate to assert that he is either wofully ignorant of science, or else a consummate humbug.

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ALGÆ IN DRINKING-WATER. — Professor W. G. Farlow, who is unquestionably one of the best informed crytogramic botanists in the country, is the author of a pamphlet of twenty-two pages, and two plates —one a lithograph and the other a heliotype-plate—entitled, "On Some Impurities of Drinking-water, caused by Vegetable Growths." The pamphlet is an extract from the "First Annual Report of the Massachusetts State Board of Health." The article is written in a popular style, and surely tends to allay any anxiety which may be engendered by the reading of extravagant newspaper reports of the contamination of water by plant-growths. The larger water plants, *Myriophyllum*, *Ceratophyllum*, *Callitriche*, *Utricularia*, *Anacharis*, *Potamogeton*, *Naias*, *Vallisneria* and *Lemna*, for example, may be the cause of trouble by choking the small streams, or by affording places of attachment for certain lower plants, which have already become quite noted for the peculiar odor and taste which they give to the water during their decomposition. Among the algæ the grass-green, filamentous species belong to the three orders, Zoösporeæ, Œdogonieæ and Conjugateæ, besides a few filamentous Desmideæ. The bulk of the larger algæ belong to the first and last orders. These grass-green forms, however, do not act injuriously upon the water; in fact they do not grow except in pure water. Some of the bluish-green, purple, at times almost black, algæ, however, are not so harmless. Among these we have the Nostocs, which are characterized by cells arranged in filaments, and the Chroöcocaceæ, in which the cells are united in colonies of no definite shape. It is to these plants that the noted pig-pen odor is due; and when large masses of them decay it is very perceptible. In 1876, Horn Pond, Woburn, became very offensive from the decay of *Anabæna*, caused by the lowering of the water and the intense heat. In 1879 the water became once more affected, this time principally by *Clathrocystis*. At South Framingham, in the same year, a green scum had formed upon a pond, but the principal plant there found was *Cœlosphærium Kuetzingianum*, associated with which was *Anabæna flos-aquæ*. Probably most of the plants belonging to the family of Nostocs, are capable of producing the pig-pen oder. The cucumber-taste, however, cannot be said to be produced by any plant.

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ALGÆ EXSICCATÆ.—Dr. Veit Brecher Wittrock, of Stockholm, and Mr. Otto Nordstedt, of Sund, Sweden, assisted by eight other algologists, have issued Fascicles VII and VIII of Prepared Specimens of Algæ. Each fascicle contains fifty fine specimens, mostly fresh-water plants, but also some marine forms. They were collected principally in European states, others are from Bra-

zil, Borneo, Ceylon, New Zealand, and the United States. A set of fifty is done up in book form, making a volume of one hundred pages, finely bound and lettered. The student of Algæ will find these volumes of much interest, and a great help in the identification of specimens, beside making a valuable addition to a library and to the herbarium.—F. W.

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FRESH-WATER SPONGES. — In a short note in the *Proc. Acad. Nat. Sci.*, of Philadelphia, a number of fresh-water sponges found by Mr. Potts in Fairmount Park, are briefly described. Three distinct species were found; one, the common green sponge of the neighborhood, resembles in appearance, and in the shape of its dermal spicules and skeleton, the *Spongilla lacustris* of Europe, but differs from it in having the spherules entirely smooth. The second form was first observed as a thin, rust-colored incrustation, but afterwards it was found to consist of spherules forming a continuous layer. This form is the *S. fragilis* of Leidy. The third form was found upon and around *Anacharis* and willow roots, matting them together and forming loose masses, several inches in diameter, yellowish or green. The spherules were globular, yellow or brown, covered with long birotulate spicules arranged radially, foramen elongated into a flaring tube, and divided into two to five tapering, slender tendrils. The sarcode decomposes early in the season. For this species the name *S. tentasperma* was proposed.

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ARCHIVES OF BIOLOGY.—We take pleasure in calling attention to a new publication, the *Archives de Biologie*, edited by Edouard Van Beneden and Charles Van Bambeke. The eminence of these gentlemen will commend the work to the scientific world, and we predict for it a hearty welcome from all students of biology. It is a quarterly publication, which, at the end of the year, will form an octavo volume of about 600 pages, and 20 or 25 plates. The subscription price is 30 francs ($6.00) or 9 francs for each number.

The first number contains some valuable contributions, among which may be mentioned the following: "Physiology of Muscles and Nerves of the Lobster," an article which gives the results of a long series of experiments upon the mechanics of contraction, and the associated thermal, chemical and electrical phenomena, and new investigations concerning the propagation of nervous impulses. The conclusions reached are that there is a complete identity in properties between the muscles of the lobster and those of the frog; and as regards the motor nerves, the difference is found in the rapidity of transmission, this being much slower in the lobster. There is an excellent article on the "Development of the Placenta of the Rabbit," and another of great interest, entitled: "New Communications upon the Living Cartilaginous Cells," by M. W. Schleicher. The article on "Ossification of the Inferior Maxillary and on the Constitution of the Dental System" we reserve for a longer notice in our next number. M. E. Van Beneden contributes an article of 83 pages, entitled "Researches on the Embryology of Mammifers," which is accompanied by three large, folded plates, beautifully colored. The last article is a description of the Bacillus of Leprosy (*Bacillus lepræ*) which is figured.

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THE NORTHERN MICROSCOPIST.—We are pleased to notice another English periodical devoted to Microscopy, which begins its career with January, 1881. It is named *The Northern Microscopist*, and the Editor is George E. Davis, F.R.M.S., F.I.C., F.C.S., etc., etc. We have long thought that there was ample room for another microscopical journal in England, which should occupy a place which the *Journal of the Royal Mi-*

croscopical Society does not fill, and we predict for *The Northern Microscopist* immediate prosperity. "Its aim is to keep a record of the proceedings of the chief Microscopical Societies in the North, and so furnish the individual member with at least as much information as he would obtain if the Society to which he belonged published its own transactions — may be more."

We congratulate the Editor upon the excellence and interest of his initial number. It contains 24 pages and one plate.

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ABBE'S BINOCULAR PRISM. — It seems to be a rather difficult matter to introduce an improvement in the microscope, which has not been anticipated by some plan of Mr. F. H. Wenham, to whom we are indebted for so many useful accessories. It now appears that a binocular prism, in some respects, identical with that of Prof. Abbe, which was described in a recent number of this JOURNAL, was devised by Mr. Wenham in the year 1866. (See *Trans. R. Micro. Soc.*, Vol. XIV, p. 104.)

Professor Abbe has since acknowledged that the plan of dividing the rays was original with Mr. Wenham, although he was not aware that Mr. Wenham had employed it when his article was written. However, the credit of having made a satisfactory application of the principle to produce stereoscopic vision, seems to belong to Prof. Abbe.

The principles involved in producing the stereoscopic effect by the new eye-piece, will be more fully elucidated in a future number of this JOURNAL.

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BEADING ON DIATOM-FRUSTULES. —From some remarks recently made before the Royal Microscopical Society (London), we infer that the question whether or not there is a beaded structure to be observed in the markings of *Frustulia Saxonica*, is likely to be opened for discussion. We would like to hear from Dr. Woodward on the subject once more. He has contended that there are no longitudinal lines on that diatom. At a meeting of the Royal Microscopical Society, Mr. T. Powell showed the *A. pellucida*, mounted dry on the cover, by the vertical illuminator; and this method of illumination showed a beaded structure on the valve. The new $\frac{1}{12}$ homogeneous immersion objective was used.

CORRESPONDENCE.

TO THE EDITOR:—The following is a simple method of making wax-cells, which may not be new, but which I have not yet seen described in any journal. The bottom of the cell may be punched from paper or wax as preferred. One of these is fixed in the centre of a slide on the turntable and with a brush moderately full of *hot* melted wax, a ring is made in the same manner as when an ordinary cement is used, and successive coats applied until the necessary size is attained. To remove the brush-marks, heat a small screw-driver or any other similar object that is sufficiently thick to retain its heat long enough, and with this mould and smooth the cell to the desired shape.

If preferred, the cell can be coated with any cement to prevent sweating. The cover may be fastened with the brush and hot wax, or in any way preferred. If not cemented a cell can be completed in two or three minutes' time.

C. BLASDALE.

NOTES.

—An English gentleman has devised a cheap and convenient arrangement for exhibiting the organisms of pond-life. It consists of a circular glass disc, revolving upon a central pin, which is attached to the microscope by means of a cross-piece which fits the stage. Near the periphery of the disc a number of cells are built up so that cover-glasses may be applied without crushing the objects. A spring is also attached to the cross-piece and reaches to near the centre of the disc, where it catches in some notches which correspond to the

cells. By revolving the disc the cells are brought successively under the objective.

—We call attention to the appearance of Amœbæ in an infusion of egg, which is mentioned in the report of the Wellesley College Microscopical Society. Possibly this may prove to be a very convenient way of obtaining Amœbæ when they are wanted. Our own experience has usually been that it is unsafe to promise them for exhibition at a given time, for they are very likely to disappear just before they are required.

—Dr. Abbe recommends the use of naphthaline monobromide as a medium for the mounting of diatoms. The index of refraction of this medium is 1.658 and the diatoms would, according to Mr. Stephenson's view (see this JOURNAL, Vol. I, page 159) be more visible in it than in Canada-balsam in the proportion of 22 to 11.

—Dr. Leidy, in the *Proc. Acad. Nat. Sci.* of Philadelphia, describes a number of Rhizopods from the top of Roan Mountain, N. C., where these organisms abound. About twenty-five species were observed.

—Those who are interested in the Gregarinæ, would do well to read a short preliminary article by Dr. B. Gabriel, published in *Zoologischer Anzeiger, III*, No. 69, upon the classification of those parasitic Protozoa. The author criticizes the present classification, and proposes a new one based upon totally different principles, which seems deserving of careful consideration.

—At the meeting of the New York Microscopical Society, held on January 7th, the following officers were elected for 1881. President, R. Hitchcock; Vice-President, E. C. Bogert; Rec.-Secretary, W. H. Mead; Cor.-Secretary, Benj. Braman; Treasurer, W. C. Hubbard; Librarian and Curator, Dr. F. M. Deems; Auditors: C. S. Shultz, James Warnock, Dr. David Benson.

MICROSCOPICAL SOCIETIES

NEW YORK.

The Fall and Winter sessions of 1880-1881 commenced with the regular meeting of September 18th, at which there was an unusually full attendance of members, many of whom had gathered and studied many objects of interest during the Summer vacation. Several visitors, interested in microscopical science, were present, among them Dr. Bates, of Brooklyn, who explained a method of preparing, staining and mounting seeds and pollen grains, a variety of which he exhibited. Mr. Hyatt showed a number of slides of diatoms, mainly *Pleurosigmas*. Some of his collections consisted exclusively of single kinds, as of the species *formosum* for example. They came from Harlem River, and he described their manner of growth and multiplication under the influences of wind and tide. One point of interest was the statement, that at certain tides, under certain conditions, these interesting objects could be obtained absolutely free from dirt. Professor W. H. Seaman, of Washington, gave the Society the results of his long experience in the use of gelatin as a mounting medium. He described the manner of preparing and applying it, and spoke very highly of its qualities for mounting purposes. The President spoke of Carbolic Acid for mounting, stating that insects could be thrown alive into the acid, in the field for instance, and thence transferred to balsam with no further trouble than a hasty draining on blotting paper, to get rid of the superfluous acid. Slides so prepared were displayed.

The meeting of October 1st was devoted to the subject of Animal Hairs, of which a great variety were exhibited, illustrating the discussion which took place between the President and Messrs Cox, Hyatt, Schöney, Shultz, and others.

On October 15th, Vegetable Hairs formed the topic of discussion, and Mr. C. F. Cox read the paper of the evening, which treated of the physiology and morphology of Vegetable Hairs. It was illustrated by slides from his cabinet. Other members displayed mounts of vegetable hairs, some of rare kinds.

At the meeting of November 5th, Doctor Schöney was the speaker, the subject being, Blood. The results of the latest investigations were stated, and after the paper was read, the lecturer demonstrated some of the properties of blood with the spectroscope. Specimens of blood from various animals were also furnished by other members, displaying the difference between the blood of fishes, birds and mammals.

The evening of November 19th, was devoted to testing wide angled objectives by oblique light. The lines on *Amphipleura pellucida* in balsam were shown by Mr. Cox, with a Spencer $\frac{1}{8}$ glycerin-immersion, of 1879, of 116° bal-

sam angle; by Mr. Warnock with a $\frac{1}{10}$ of 1879, glycerin-immersion 100° balsam angle; by Mr. Hyatt with a Gundlach $\frac{1}{8}$ just made, said to be of 140° balsam angle, the immersion fluid being Sulpho-Carbolate of Zinc; and by Mr. Mead, with a Zeiss $\frac{1}{8}$ homogeneous immersion, of May, 1880, 113° balsam angle and a Powell and Lealand water-front $\frac{1}{8}$ of 1877. Mr. Shultz, with a Spencer professional $\frac{1}{8}$ (intermediate series) immersed in a mixture composed of glycerin and water, in equal parts, showed the lines on *Nitzchia curvula* in balsam. In every instance the lines were plainly visible.

Insects' Eggs furnished the subject for December 3d, and Messrs. Shultz, Braman, Julien, Bogert and others, entertained the members with a fine display. The President read a paper on "Cells, their Growth and Functions" being the preliminary one on the subject. The general characteristics of animal and vegetable cells were described.

At the meeting of December 17th, Mr. Hyatt, exhibited and described two rock sections, one cut from a boulder of the Westchester Drift, composed almost entirely of Foraminifera, the interest in which arose from the locality where it was found, in Westchester County, remote from any known foraminiferous deposit. The other, was cut from a conglomerate of sand and shells, in a matrix of iron, supposed to owe its origin to an iron nail, lying on and at the bottom of a river. Mr. Shultz exhibited and described a wood-ant mounted without pressure (shown under polarized light) and directed attention to the clearly defined muscular system of the insect. The subject of the meeting being Insects and their parts, many objects of this nature were exhibited. Messrs. Braman, Hyatt and others, discussed the question of the purposes of bristles on the hairs of the antennæ of insects, and also the subject of the attraction of male to female moths under the influence of odors emanating from the latter. Mr. Braman had calculated the number of molecules, in the smallest space visible to the unassisted human eye. This space (the $\frac{1}{400}$ of an inch according to Ehrenberg) cubed, contained about 7,500,-000,000,000,000 molecules. Dr. Deems said that he had observed in the stomach of a living bed-bug human blood-corpuscles, and had noticed that these insects chose as a favorite spot for their attacks, the sweat pores. The President alluded again to the advantages of Carbolic Acid as a mounting medium. He also said that except for special purposes, mounting insects under pressure was likely to become a thing of the past, in view of the superior opportunities for study, presented by mounting them in living attitudes. He described and illustrated by drawing, the process of multiplication of a species fresh-water alga the *Coloeochœte scutata*.

W. H. MEAD, *Sect'y.*

WELLESLEY COLLEGE.

The second regular meeting of the Wellesly College Microscopical Society for the College year, was held Monday evening, December 13th, with the President, Miss Hayes, in the chair. The following subjects were presented: A paper on the Yeast-Plant, by Miss D. F. Waterman, illustrated with drawings. A paper on the Detection of Forgery by means of the microscope, by Miss E. Hurll. Professor Nunn gave an account of a discovery she had lately made of Amœbæ in a remarkable way, from an infusion of the yolk of hen's egg in Pasteur's fluid. In about ten days, when the odor of decomposition had become quite strong, Amœbæ were found in such great abundance as to form a creamy deposit on the surface of the liquid; and a drop examined from any part of the fluid, showed hundreds on the field. They varied a great deal in size, and had a remarkably active and amœboid movement. Generally a nucleus could be distinctly seen. They seem not to make their appearance in water and egg alone, and apparently flourish best when ammonium tartrate is replaced by pepsin. Their whole history, whether they originate from white or yellow yolk, and in what manner, has not been ascertained; but it would seem that the matter involves questions of considerable interest.

There were shown, under the microscope, specimens of yeast-plant, also a genuine and a forged signature, in which the difference could be distinctly seen.

L. F. CLARKE, *Cor. Secretary.*

CENTRAL NEW YORK.

The Society met at the office of Dr. Aberdein, in Syracuse, on the evening of November 30th, with a good attendance. The members of the Society had the pleasure of meeting Dr. Clifford Mercer, editor of the micro-photographical section of the last edition of Beale's "*How to Work with the Microscope.*" Dr. Mercer brought with him his No. 3 Powell & Lealand

stand and exhibited its working, together with some objectives and accessories. Its workmanship and finish was of the highest class and the various movements were admirably smooth and even.

An interesting demonstration was given by the President, Mr. Geo. K. Collins, of Prof. H. L. Smith's quick method of mounting diatoms in hard balsam. Some miscellaneous work prepared by the various members of the Society was exhibited.

CENTRAL ILLINOIS.

The third regular meeting was adjourned from November 11th to the 18th, to enable some of the members, who were attending the Tri-state Medical Association in Louisville, Kentucky (Dr. Buck, of this Society, being President of the Association), to be present. The paper for the evening was read by Dr. Matthews, the President. The Doctor's subject was "The Science of Optics as applied to the Microscope." He treated his subject well, making all his statements clear and accurate. His black-board illustrations were very fine. A number of interesting objects prepared by the different members were examined.

The instruments in use during the evening were by R. & J. Beck, and Crouch, of London, and by Edward Kahler, of Washington, D. C.

THE FORT WAYNE MICROSCOPICAL SOCIETY

was organized September 18th, 1880. Regular meetings are held on the second Friday evening, and social meetings on the fourth Friday evening, of each month, at the residences of the members.

The officers are as follows: President, F. W. Kuhne; 1st. Vice-president, C. A. Dryer, A. M., M. D.; 2d. Vice-president, G. W. McCaskey, M. D.; Secretary, C. L. Olds; Corresponding Secretary, Lem. R. Hartman; Treasurer, Paul F. Kuhne.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—Polycystina, Foraminifera. Diatomaceous Earths, or other material or mounted objects, in exchange for Diatoms *in situ* and free, Diatomaceous Earths, Algæ, and many of the other Cryptogramia showing structure or fructification, and a large variety of miscellaneous material. Only strictly first-class objects offered or desired.
M. A. BOOTH, Longmeadow Mass.

For diatoms *in situ* on Algæ, send mounted slide to K. M. CUNNINGHAM, Box 874, Mobile, Ala.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Fine injected specimens of kidney, tongue and liver, also very fine slides of human tooth, prepared according to the method of Dr. Bödecker, showing the protoplasmic net-work between the dentinal canaliculi, in exchange for first-class histological and pathological slides, or other good specimens.
J. L. WILLIAMS, North Vassalboro, Me.

Slides of hair of *Tarantula*, very curious; also crystalline deposits from urine, to exchange for well-mounted slides. S. E. STILES, M. D.,
109 Cumberland St., Brooklyn, N. Y.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

Diatomaceæ from Lake Michigan (Chicago water supply), mounted or raw material; also diatoms from other localities, to exchange for well-mounted Diatomaceæ or other objects of interest. B. W. THOMAS,
1842 Indiana Ave., Chicago, Ills.

Lime sand, composed almost exclusively of microscopic Foraminifera, to exchange for microscopic material. H. A. GREEN, Atco, N. J.

Polyzoa, Palates of Mollusca, Foraminifera, Sponge and Holothurian-Spicules, Synapta-Anchors, Chirodota-Wheels, Echinus-Spines, Minute Sea Shells, in exchange for Polyzoa, Foraminifera, Histological and Pathological preparations, *etc.* Also, a quantity of Sea Shells in exchange for Land and Fresh-Water Shells.
F. M. HAMLIN, M. D., Auburn, N. Y.

J. J. B. Hatfield, Arsenal Avenue, Indianapolis, Indiana, will exchange Bleached Plant-Sections for good Diatomaceous material. List furnished on application.

To exchange, well-mounted Slides of Hair for mounted or unmounted specimens of hair from the rarer animals; lists exchanged. WM. HOSKINS,
208 S. Halsted street, Chicago, Ill.

Slides mounted from injected Frog's Gall-bladder, Liver, Kidney, Stomach, Intestine and other parts, exchanged for other good and interesting preparations. C. BLASDALE, M. D.,
Jericho, Queens Co., N. Y.

BINDING.

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The Griffith Club Microscope.

The microscope which is illustrated by cuts in this number of the JOURNAL, is the invention of E. H. Griffith, A. M., of Fairport, N. Y., and is the result of several years of experimenting, by the inventor, while absent from home and engaged in commercial pursuits. It received its name from the Griffith Club of Microscopy, of Detroit, Mich. Originality is claimed in nearly every part

FIG. 4.—Microscope, the foot converted into a Turn-table.

of its mechanism, and practicability in all. Among its novel and good features may be noticed the base, which may be instantly converted into an excellent turn-table, which may be held by the microscope-body as a support, as in Fig. 4, or by a screw-clamp attachment, which is

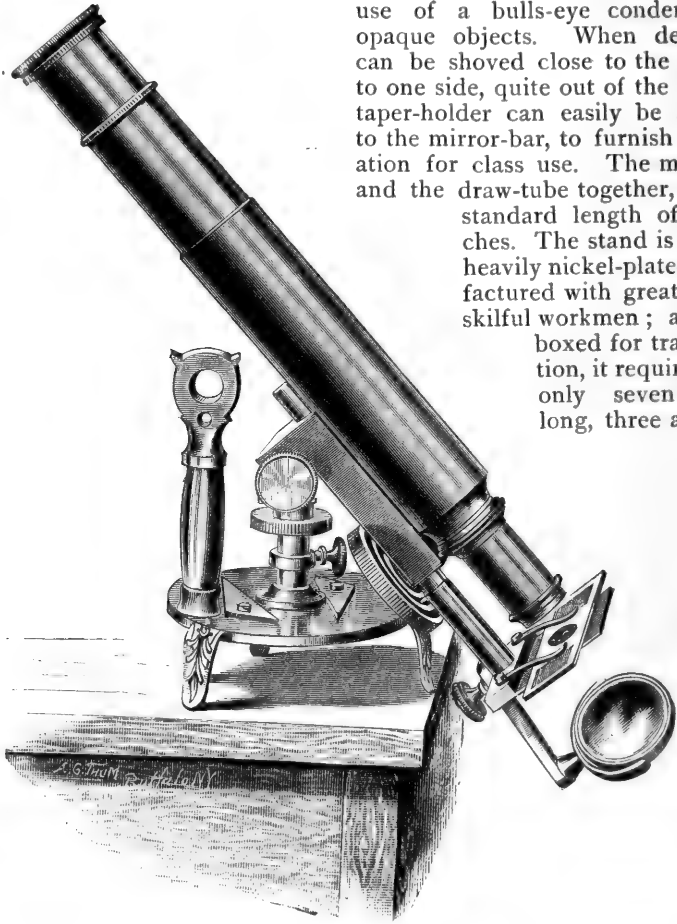

FIG. 5.—Griffith Club Microscope, E. H. Griffith's patent.

also original and used to clamp the microscope to its box when used with the turn-table base, or to clamp the body to any support when the base is removed. The fine adjustment is made by a spiral grooved-wheel, which is very convenient and very practical, allowing the use of the highest power objectives, while the coarse adjustment and the draw-tube will permit the lowest powers to be employed. The mirror-bar is so made that the mirror can be placed at any angle above or below the stage, allowing the greatest obliquity of illumination for tests, and dispensing with the use of a bulls-eye condenser for opaque objects. When desired, it can be shoved close to the stage, or to one side, quite out of the way. A taper-holder can easily be attached to the mirror-bar, to furnish illumination for class use. The main tube and the draw-tube together, give the standard length of ten inches. The stand is of brass, heavily nickel-plated, manufactured with great care by skilful workmen ; and when boxed for transportation, it requires a box only seven inches long, three and one-half inches wide, and two and one-half inches deep, interior measure. In addition to the stand and turn-table attachment, three objectives of the largest size, an extra eye-piece and other accessories, can be put in the same box ; when set up for use it is a full size microscope, capable of

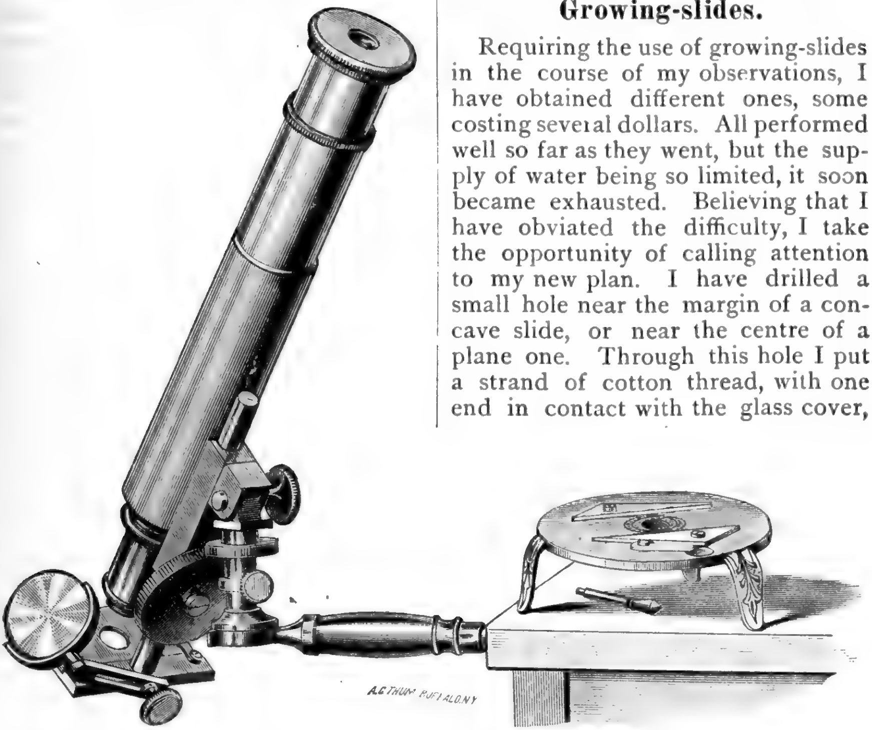

FIG. 6.—Microscope attached to a desk or another support, by the screw-holder. The Turn-table can also be attached in the same manner.

being set at any inclination, from perpendicular to horizontal ; and it may be kept in such a position ready for service, or it may be quickly packed and placed in an overcoat-pocket, or other small space for transportation. The box is of black walnut except the cover, which is of heavy plate-glass.

Mr. Griffith has already received a number of orders for this microscope, but has delayed filling them until the instrument was perfected to suit him. Probably he can now furnish them on short notice. The price is lower than would be expected from an examination of the instrument. We are not sure that it is definitely fixed, as yet, but it will be about twenty-five dollars, including a black walnut box with a plate-glass cover.

——o——

Growing-slides.

Requiring the use of growing-slides in the course of my observations, I have obtained different ones, some costing seveıal dollars. All performed well so far as they went, but the supply of water being so limited, it soon became exhausted. Believing that I have obviated the difficulty, I take the opportunity of calling attention to my new plan. I have drilled a small hole near the margin of a concave slide, or near the centre of a plane one. Through this hole I put a strand of cotton thread, with one end in contact with the glass cover, the other immersed in a vessel containing the water, which in my own case, is a soap-dish on which I rest the slides. Thus I have a perfect circulation, limited only by the large supply of water. The advantages of this plan are that it is inexpensive, and the glass slip can readily be used as an ordinary slide, besides the opportunity one always has, of finding anything on the slide worth future study, and of immediately converting it into a growing slide, thus avoiding the loss of rare objects, which it is sometimes desirable to preserve for further study.

W. H. WIGHT.

BALTIMORE, MD.

——o——

—A late number of the *Bulletin of the Torrey Botanical Club*, contains an article by Mr. Wolle, on New American Desmids, with a plate.

Receipts for Microscopists.*

BY JULIEN DEBY, C.E., F.R.M.S.

All those who have had practice with the microscope have, through personal experience, discovered for themselves some special "dodges" which have facilitated their researches, or enhanced the efficiency of their instruments. If such persons would condescend to publish their results in this respect, they would render service to others laboring under difficulties which they have overcome. It is in order to induce members of the Quekett Club to follow my example, that I this day draw their attention to a few simple adaptations of means to ends.

I.—When allowing all but adepts in the use of the microscope to peep through my high-power glasses, I have often felt a certain degree of uneasiness, not to say of alarm, regarding the fate of valuable test-slides, or still more valuable objectives. Many others here present have no doubt experienced the same discomfort which I find an easy matter to attenuate to a considerable extent, by focussing from the eye-piece instead of from the coarse or the slow motion. All that is needed for this is a rack and pinion to the eye-piece of considerable length. An inch or two up or down corresponds here to a fraction of a turn of the fine adjustment of the microscope, so that very little danger exists of any sudden contact with the covering glass. As soon as an indistinct view of the object is obtained through the ordinary coarse adjustment of the microscope body, the focus is brought to exactness by means of the coarse motion of the eye-piece without much difficulty. For demonstrations or exhibitions in public, microscopes could thus be made without the ordinary fine motion.

II.—When mapping with the micro-spectroscope, the difficulty of measuring exactly the position of fine lines or absorption bands is often great, even when using the admirable micrometers invented by Mr. Browning and Mr. Sorby. I find that in most practical cases the micro-spectrum can be thrown upon a sheet of white paper by means of an ordinary camera lucida placed over the eye-piece of the spectroscope. Strong light by means of a condenser has to be thrown through the liquid under examination. By means of an ivory rule, finely divided, and brought back to a known line, say D, all other lines or bands may be directly measured off on the rule, and, if desired, the exact results in millionths of a millimetre may then be computed by any of the known interpolation formulæ, such as are given in Suffolk's useful little book.*

III.—The arrangement of small microscopic objects, such as diatoms, foraminiferæ, etc., on slides in regular lines, circles, or patterns, can be much facilitated in the following way:—Draw with a pen and ink cross lines, or circles, or any other figure required on the surface of the plain mirror of the microscope; then focus down until the image of these lines is seen on the upper surface of the top lens of the condenser. By means of a mechanical finger, or of a steady hand with a rest, no difficulty will now be experienced in placing the objects in perfectly regular order.

IV.—I now obtain excellent condensed monochromatic light by means of a bull's-eye of unusual external shape, the internal portion of which, however, is filled with glycerin or oil of cloves colored to suit. This bull's-eye has a plane back and a concavo-convex front, and the liquid is introduced through a hole in the flat side, closed by a small ground stopper. This apparatus is furnished with universal motions, and has a rack and pinion foot. It was made for me by

*From *The Journal of the Quekett Microscopical Club.*

**Spectrum Analysis as Applied to Microscopical Observations*, W. T. Suffolk, F.R.M.S. London, John Browning, 63, Strand 1873.

Mr. J. Browning. When using blue light, produced by ammonia sulphate solutions, I have resolved, by means of this monochromatic bull's-eye *Amphipleura*, with objectives in my possession, which will hardly show *Pleurosigma angulatum* under ordinary condenser illumination.

V.—Some time ago, Mr. J. E. Ingpen, on my behalf made a communication to the Club in regard to a growing slide I had devised for some special researches I was following at the time. Some difficulty seems to have been found in the making of these slides, so that it is with pleasure I now offer a still more simple contrivance for obtaining the same results. Here is the receipt: Take an ordinary glass slip with a circular hole, say half an inch or more in diameter in the middle; lay this slip on an ordinary glass slide, not perforated. Then grease the top of the upper or perforated slide just a little way around the circular hole, and join the two slips of glass by means of two rubber rings. The object is then placed on a thin cover-glass, somewhat larger than the hole in the slide; it is then covered by a thin glass cover, ¼ inch in diameter; the whole is then turned down and fastened to the slide by the adherence with the grease, while the small cover prevents the running of the liquid. The plant or animal under examination finds itself confined in a sort of miniature Ward's case. When not under observation, the growing slide is laid flat in a shallow plate with water just above the line of junction of the two slips of glass, where, by capillarity, it creeps up to the central cell, where evaporation keeps the contained atmosphere in a state of constant and healthy saturation.

VI.—*Copal Varnish.* I find this varnish dries very rapidly if slightly heated, or even if placed on a previously warmed slide. I have many hundred slides of diatoms prepared in copal varnish, and my friend, Mr. Van Heurck, of Antwerp, who was the first to use this material, has many thousands. The varnish to be used is what is called the "pale copal," and its consistency ought to be that of oil. It is much pleasanter to use than Canada balsam, does not make bubbles, and its refractive index is not very different from that of balsam, and does not interfere with the resolution of diatom markings. I have of late made many preparations in copal dispensing with the cover-glass altogether. The drop of copal is placed on the diatoms and heated slightly over the spirit lamp. It soon takes the consistency of amber, and is hard enough to sustain wiping and brushing with a soft brush with impunity. The optical aberrations produced by the cover-glass are thus done away with.

I hope at some future day to add a few more "Receipts for Microscopists" to the above list; may the above, however, in the meantime lead to similar communications from brother microscopists.

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Form-cycle of Glœocystis.*

BY PAUL RICHTER.

The fact that different fresh-water algæ, such as the free spores of *Draparnaldia*, the resting conditions of *Chlamydomonas*, and the early stages of *Urococcus*, form enveloping membranes like *Glœocystis*, has made the limitation and determination of the latter genus very uncertain, if the habitat is not known. Whoever has been engaged in collecting algæ, will fully agree with me, that local circumstances often influence the forms of certain algæ in a very special manner, and that the habitat possesses a signification here, just as in the case of the other plants. For example, *Glœocystis*, according to Nägeli and to the author (*Einzellige Algen*, p. 66), occurs upon moist wood-work and stones, not free in water or upon submerged objects, or among other algæ like *Clamydomonas*,

* Translated from *Hedwigia*.

etc. In water, *Glœocystis* loses its gelatinous structure, and falls to the bottom just as a phænerogamic plant would do if it were required to develop as a swimming plant in river or pond.

The relations of the algal vegetation to the bottom and to the medium being given, one would necessarily have to seek for the forms of *Glœocystis*, also those of *Glœocapsa*, in accordance with their original habitats, only upon moist bottoms exposed to the air, as upon moss, boards, stones, rock-walls and similar places. It seems strange to me, therefore, to find habitats of another kind, such as ponds, ditches and bog-pools, given in botanical works for *Glœocystis*, and certainly, in these instances, the naked conditions of other algæ have been confused with *Glœocystis*.

There lie before us two articles which greatly enlarge the scope of the genus *Glœocystis*, and show close relations with the Volvocineæ and the Hydrodictyeæ. Cienkowski * found in *Glœocystis vesiculosa* vacuoles and swarm-spores which, excepting the absence of the pigment-spot, were quite similar to those of *Chlamydomonas*, and Lohde † observed in an undetermined species, after the formation and arrangement of the spores, an affinity with the Hydrodictyeæ. Accordingly, we would have three types of *Glœocystis* to distinguish, one which is related to the Volvocineæ, another to the Hydrodictyeæ, and a last and most low in organization which corresponds to the Palmellaceæ.

Since I have assumed to regard only the last group, which is only to be found upon moist surfaces exposed to the air as *Glœocystis*, I must regard the results of the investigations of Cienkowski and Lohde, in themselves of the greatest value, as relating to the Volvocineæ, not to *Glœocystis*.

* *Bot. Zeit.*, 1865, No. 3.

† Shenk and Lürssen, *Mittheilungen aus dem Gessammtgebiete der Botanik*, I Band, p. 478-485.

Cienkowski has described and figured a *Pleurococcus superbus* from a pond; but in Rabenhorst's *Flora Europ. Alg.* III, p. 29, this is given as a synonym of *Glœocystis ampla*. In the same article Cienkowski has drawn *Glœocystis vesiculosa* into the line of the investigation, and figured it to show its great resemblance to *Chlamydomonas*; unfortunately, the place where it was found, a consideration to which I attach importance, is not stated. It would certainly be unjust to refer it to the same place as the *Pleurococcus superbus*; but I am not inclined to assume for it the normal habitat, particularly as my many weeks of observation on *Glœocystis* from moist rocks, moss-cushions and the like, showed no vacuoles or swarm-spores like *Chlamydomonas*, but rather indicated a form-circle of its own. Lohde's *Glœocystis* with a very thin envelope, from the bottom of a glass vessel, and which occurs also in ponds, is apparently a condition of *Chlamydomonas*, which is known to form different spores under different conditions.

I was able to cultivate for a long time a *Glœocystis* which I collected from moist-boards, rocks and moss, but I have not succeeded in observing spores and swarm-cells. Among freshly collected jelly-masses from rock-walls and moss, with *Gl. rupestris*, Rab., I often found pale, stellate, and at other times green, spherical, spinous cells with a hard coat, 8–14.$^{\mu}$ in diameter, which I might take for resting-spores; their true position must, however, remain to be indicated by further observation. In other cases my observations have shown that *Glœocapsa monoccoca*, Ktz., and *Glœocapsa stillicidiorum*, Ktz., *Tab. Phyk.*, I, f. 20, come together, and are to be placed in the form-circle of *Glœocystis vesiculosa*; further that *Palmoglœa lurida* and *rupestris* belong to *Glœocystis rupestris*, Rab. In the Spring of this year I collected from moist boards, *Glœocapsa monococca*, Ktz. (*Tab. Phyk.*, I, f. 23).

This alga, because of the circumstance that it assumes a steel blue color from lack of sufficient moisture, has been subjected to different systematic classifications. I have drawn attention to this changing coloration in *Botan. Centralbl.*, No. 19, p. 605, and endeavored to explain it, by showing that the quantity of water influenced the color. In *Phykol. Generalis* we find it, p. 175, as *Glœocapsa* with *gonidiis æruginosis ;* later in *Spec. Algar.*, p. 229, as *Palmoglœa monococca* f. *æruginosa.* Nägeli* considered it as a *Glœothece*, and Rabenhorst followed him in this conclusion (*Flora Europ. Alg.*, Vol. II, p. 62), and Kirchner (*Kryptogamenfl. Schles.*, Vol. II, first half).

The contents of the young cells in the upper vegetation are evenly distributed within them, finely granular, and there is a faintly defined, laterally placed chlorophyll vesicle, which sometimes seems to be absent. Or, the contents are arranged on one side of the cells, in the line of the axis, and form on one of the sides a conchoidal body which fills one-half of the cell up to a sharply defined limit, while in the other half only bluish protoplasm is to be seen. This grouping of the contents is characteristic. The cells are elliptical, but in many cases the end is somewhat pointed. The length is variable, 7–12μ, the breadth 4–8μ. As a rule, the cells are enveloped in a gelatinous coat, which is often so delicate as to be only visible in dried specimens.

The cell contents are sometimes arranged in still another manner. The chlorophyll is then found to be restricted to half the cell, but the well-defined border runs diagonally. It seemed to me as though a shifting of the chlorophyll took place. Again, the chlorophyll may also be uniformly distributed in a lateral, half circular segment or clear stripe, which extends from the border to the middle, so that the chlorophyll mass appears more or less horse-shoe or kidney-shaped. Such chlorophyll grouping is also found in *Palmogœa rupestris, lurida* and *micrococca* drawn by Kützing in *Tab. Phyk.*, I, T. 25. I would consider the latter, without hesitation, as identical with *Glœocapsa monococca*, did not the statement of Rabenhorst* about angular zygospores oppose this view, for the fungus-hypha, which spreads around the envelope of *P. micrococca* likewise appeared in this.

In those individuals, the contents of which were evenly distributed, and which also were somewhat swollen, there appeared, previous to division, a separation into four spherical or elliptical, peripheral balls, which soon formed elongated egg-shaped bodies, and occupied the entire cell, two being in the line of the axis and two at a right angle to these. Usually the mother-cell bursts and the exit of the daughter-cells follows, which in turn continue this division ; or else the mother-cell expands, assumes a spherical or cylindrical shape, with a length of 17μ, 19μ and 30μ, and encloses daughter-cells and later generations. A special gelatinous membrane does not always appear for the daughter-cells ; the latter then remain free in the general mass of jelly. I also observed cases in which the mother-cells divided into only two daughter-cells, likewise placed in the line of the axis, which by shifting and at the same time extending the envelope finally rested one behind the other. This formation of daughter-cells takes place by free cell formation, and might be regarded as a suppressed swarm-spore formation, especially since I found, in later and similarly shaped generations, a quadruple division in which the short, cylindrical daughter-cells all collected together, parallel with the longitudinal axis—a multiplication which took place by repeated binary division in one and the same direction, and corresponded to a vegetative process. One might easily be led to regard

* *Einzellige Algen*, p. 52.

* *Flora Europ. Alg.* III, p. 116.

such small bladder-like cells, as a new species of *Oocystis*, if its further development did not show that we have to deal here with one of the forms of *Glœocystis vesiculosa.*

(*To be continued.*)

The Preparation and Mounting of Objects.

V. A few special methods were promised for this number of the JOURNAL. The first one to be mentioned is Stodder's method of mounting diatoms. This method is sometimes useful when rather large diatoms are to be mounted *in situ*, in balsam. Diatoms mounted in this way sometimes form very beautiful objects for the paraboloid illumination. It is necessary to remove all the air from within the valves, and as this is sometimes a difficult matter, Stodder's method is a very good one.

The diatoms, attached to the bit of sea-weed or other object, are thoroughly dried, and immersed for a short time in chloroform. They are then transferred to the slide and a few drops of balsam dissolved in chloroform are quickly added. As the chloroform evaporates from the frustules, the balsam-solution takes its place, so that the diatoms are all filled with balsam and free from air-bubbles, while the appearance of the sea-weed is not injuriously affected. Benzole and benzole-balsam will act equally well. With such frustules as the *Isthmia*, we have made some beautiful slides in this manner.

Mr. C. C. Merriman's method of mounting Foraminifera gives very fine results with some shells, particulary with flat ones like *Peneropolis*, *Orbiculina*, etc. The shells are carefully selected and immersed in spirits of turpentine. They are then transferred to a drop of balsam on a cover-glass, tastefully arranged, and the balsam is then thoroughly hardened by heat. When the balsam is hard it is coated with asphalt, and this also is allowed to dry thoroughly. The cover-glass is then mounted on the slide. We thus make an opaque balsam-mount and the white shells show very well against the black ground of the asphalt.

Polycystina may be mounted as transparent objects in balsam, but very beautiful slides can be made in another way. The glassy appearance of the Polycystina makes them inferior objects when mounted dry in opaque cells, but if they are heated on platinum-foil, mica, or on some other support, either by means of a blow-pipe flame or over a lamp, they lose their glassy appearance and become opalescent. They are then very beautiful objects for opaque mounting.

Polyzoa and Zoophytes are always interesting objects if properly prepared. The encrusting Polyzoa would naturally be mounted as opaque objects but the plant-like forms may sometimes be mounted in balsam, or even dry, for transmitted light. When they are mounted as opaque objects they usually require but little cleaning, but for transparent objects it is desirable to remove the contents of the cells. It is to be understood that we are writing about the dried specimens, not of the living animals. The usual method of cleaning the polypidoms is by the use of the air pump, but we have succeeded very well without it in this manner: First boil the objects in a test-tube in water, to remove the air from the cells; then soak them in a saturated solution of washing soda (carbonate of soda), and then pick them out of this solution with forceps and dip them into dilute hydrochloric, or some other acid. The rapid evolution of gas that ensues drives out the contents of the cells, and often cleans them perfectly. They should then be preserved in alcohol, or in camphor-water. Another process for removing organic remains, is to place the objects in water and allow decomposition to take place.

Supplementary Note to the Notice of "Riddell's Binocular Microscopes."*

BY SURGEON J. J. WOODWARD,
Bvt. Lt. Colonel, U. S. Army.

I have just received from my friend, Mr. John Mayall, Jr., a note calling my attention to a partial acknowledgment of the priority of Riddell made by Mr. J. W. Stephenson in a communication to the Royal Microscopical Society, June 4th, 1873.

I regret very much that this acknowledgment should have entirely escaped my notice, and hasten to give it equal publicity with my paper. (This JOURNAL, Dec., 1880, p. 228.) It will be found in the Report of the Proceedings of the Royal Microscopical Society for June 4th, 1873 (*The Monthly Microscopical Journal* Vol. X, 1873, p. 41) in the following words: "Mr. J. W. Stephenson said he took the present opportunity of stating that, to his surprise, he found that the mode of dividing the cone of light in his erecting binocular microscope by means of two prisms was used by Professor Riddell, of New Orleans, in the year 1853, in his form of binocular. The arrangement of that instrument differed from his own in the following respect, *viz.:* that his (Mr. Stephenson's) prisms were so placed that, combined with the reflecting plate above they acted as an erecting instrument, and by entering into the cell of the object-glass could be used for high powers whenever required; whilst those of Professor Riddell were placed above the object-glass simply to produce binocular effect. He had only just heard of this through the kindness of Mr. Frank Crisp, and he took the earliest opportunity of notifying it to the Fellows of the Society."

But while hastening to give due credit to Mr. Stephenson for this acknowledgment, I cannot but express my surprise that, so late as 1875, Dr. Carpenter, in the work cited in my paper, should have continued to give the credit of Riddell's invention to Mr. Stephenson; nor am I less surprised that the latter gentleman, after his attention had been called to Riddell's invention by Mr. Crisp, should have studied it so imperfectly as to have overlooked the upper prisms, by which Riddell's microscope also "acted as an erecting instrument" so many years before. The arrangement of Mr. Stephenson by which his prism "entering into the cell of the object-glass could be used for high powers whenever required," is, as I pointed out in my paper, a real improvement on Riddell's instrument, for which I have already given Mr. Stephenson full credit.

ARMY MEDICAL MUSEUM.
January 18th, 1881.

* See this JOURNAL, December, 1880, Vol. I, p. 221.

Riddell's Binoculars.

A LETTER FROM MR. J. W. STEPHENSON.

I have read with much interest Colonel Woodward's historical notice of Riddell's Binocular Microscope, which appears in the December number of your JOURNAL, but at the same time I am not a little surprised that he has supposed it to be necessary now to make an appeal to me, to "hasten to accord full credit to Professor Riddell" inasmuch as the *Proceedings* of the Society of which he is an Honorary Fellow (The Royal Microscopical Society), record that I did so nearly eight years ago. The matter is thus reported in the *Monthly Microscopical Journal*, Vol. X (1873), p. 41: "Mr. J. W. Stephenson said he took the present opportunity of stating that, to his surprise, he found that the mode of dividing the cone of light in his erecting binocular microscope by means of two prisms was used by Professor Riddell, of New Orleans, in the year 1853, in his form of binocular.

The arrangement of that instrument differed from his own in the

following respect, *viz.:* that his (Mr. Stephenson's) prisms were so placed, that, combined with the reflecting above, they acted as an erecting instrument, and by entering into the cell of the object-glass could be used for high powers whenever required; whilst those of Professor Riddell were placed above the object-glass simply, to produce binocular effect. He had only just heard of this through his friend Mr. Crisp, and he took the earliest opportunity of notifying it to the Fellows of the Society."

It is not surprising that I was ignorant of what had taken place seventeen years previously, as the microscope was a comparatively new instrument in the year 1870; but it is surprising that Thomas Ross, by whom my instrument was constructed was also unaware of the fact, as he pressed me strongly to allow him to patent it at his own expense, thus conclusively showing that he had no idea that the light had been so divided before.

If Colonel Woodward read my disclaimer at that time, he will, I am sure, regret that he had forgotten it when writing his paper to which I have referred.

My reinvention of the instrument arose as follows: I was at work on the Polycystina and could never overcome the difficulty of picking out new, or rare species in consequence of the inversion of the image; this induced me to apply myself to some device by which the difficulty could be overcome. I soon saw that if a binocular could be constructed with one reflection in each plane, the object would be accomplished—this, almost of necessity, suggested the reflecting prisms for lateral inversion, and the vertical inversion followed as a matter of course.

Such was the original instrument, made for me by Ross, which gave him so much satisfaction.

It nevertheless soon occurred that the large dividing prisms *above* the objective were a mistake, as by using smaller prisms which could be inserted in the objective so as to nearly touch the back combination, there was apparently no limit to the power which could be used; at the same time, it became evident that the upper prisms were, with their three surfaces, an optical error when one reflecting surface only was required—this led to the substitution of a *plate* of glass, silvered on one side and black (polished) on the other, which, by rotating on a horizontal axis, could be instantly changed from its ordinary use (with its silver side) to that of an anilizer, for which purpose, as a still further improvement, the bodies had been fixed at the polarizing angle.

The result of the substitution of the smaller prisms was as anticipated, and I was thus enabled, at one of our "scientific evenings," to show "Podura" under a $\frac{1}{25}$-inch* with both fields perfectly illuminated—whilst the reflecting plate disposed of the receiving and transmitting surfaces of the original prisms as well as of the mass of glass of which they were constructed.

In conclusion I may add that the fact that Professor Riddell had ever directed his attention to the question of erecting the image in any form was quite unknown to me, and I will only repeat that I as fully disclaim now all intention of claiming priority for my original instrument, as I did eight years ago, when Mr. Crisp kindly drew my attention to the subject, nor do I regret (as far as I am concerned) that colonel Woodward did not see, or had forgotten, the disclaimer which I then publicly made, as it affords me another opportunity of doing justice to Professor Riddell, although, as I have shown, I was not in fact indebted to him for any of the ideas which led me to the invention.

J. WARE STEPHENSON.

LONDON, January 4th, 1881.

* Recorded in the *Monthly Microscopical Journal.*

On Ossification and the Constitution of the Dental System of Balænoptera Rostrata.

The results of the researches of Mr. C. Julin, conducted upon the fœtus of this animal, are given in full in the *Archives de Biologie* as mentioned last month, and occupy about fifty pages of that periodical. The article is illustrated by two large and beautifully colored plates. The general conclusions are given as follows :—

1. I have confirmed the existence of follicles, or of *germes dentaires*, in the inferior maxillary of the fœtus of *Balænoptera rostrata.*

2. In this maxillary, $84^{mm.}$ in length from the symphysis to the condyloid extremity, there are forty-one follicles lodged in the alveolar groove of the symphysis at the coronoid process, and disposed in a continuous series.

3. These dental follicles present the same constitution as those of all other mammifers; their texture is precisely the same.

4. The dental system of our Balænopter only recalls that of the Cetodonts by the very considerable number of teeth ; if the system is based upon the consideration of the form of the organs, the Mysticetes are more closely allied to the Pinnipedes and especially to the Squalodons.

5. Among the true Cetacea there are none of which the dental system can be compared with that of our Balænopter. All the Cetodonts (Delphinides and Ziphioides) are homodonts, and their teeth are all caniniform, conical, and have a simple root. Our Balænopter is heterodont, like the Pinnipedes and the Squalodons, and its dental system corresponds by its composition, to that of the Squalodons; based upon the comparative study of the dental system, the Mysticetes, close neighbors of the Squalodons should be considered like the latter, as a transition type between the Cetodonts and the Pinnipedes, to which they are connected by the intermediate Zeuglodons.

6. Meckel's cartilage intervenes in the formation of the bony maxillary : it gives origin to some bony channels (*travées*).

7. These bony channels are made continuous with the osseous channels formed at the expense of other tissues entering into the composition of the bony maxillary, by the medium of a deep osseous channel developed at the expense of the perichondrium.

8. In the beginning, the single intra-osseous portion of Meckel's cartilage suffers modifications in its structure, the extra osseous part remains constituted like hyaline cartilage.

9. The ossification of Meckel's cartilage takes place in a manner analogous to that of the cartilaginous nucleus of the diaphyse in the ossification of a long bone.

10. The condyle is formed by a cartilaginous nucleus which becomes ossified.

11. The coronoide apophyse is not composed of cartilage, as in man.

12. The formation of medullary spaces in a cartilaginous nucleus (Meckel's cartilage or condyle) during ossification is due to modifications which the fundamental substance of the cartilage may undergo; it may be either calcified, impregnated with bony substance, or even hypertrophied (condyle).

13. The young medullary tissue, either when the ossification of the cartilage or of the conjunctive tissue proper is concerned, is the result of modifications undergone by the osteogenous tissue. Its texture is the same as in the other case.

14. The osteoblasts form at the expense of the elements of the young medullary tissue.

15. The beginning of the ossification of one or the other of the tissues constituting the inferior maxillary, corresponds to what is understood by "direct or metaplasmic ossification."

16. There is complete analogy between the ossification of cartilage and that of conjunctive tissue, properly so-called.

17. At the condyle I have met with the two processes of direct ossification of cartilaginous cells described by M. Strelzoff.

18. The formation of osseous tissue at the expense of the osteoblasts takes place according to the processes described by Waldeyer.

19. Finally it is necessary to consider direct and indirect ossification as two phases of the same process of formation.

Working-distance and its Relations to Focal Length and Aperture.

BY ERNST GUNDLACH.

Working-distance is the usual designation of the space between the object and the objective on a microscope, when the former is brought into proper focus ; or, in other words, when the objective is brought to such a distance from the object, that by means of the former, an air-image of the latter may be formed at a distance of ten inches.

The working-distance of an objective depends upon, 1, the focal distance ; 2, the aperture ; 3, the number of lenses of which the objective consists ; 4, the proportionate curvatures of the lenses ; 5, the thickness of the lenses.

Theoretically, the working-distance of an objective will be the longest possible if the aperture be infinitely small, and the objective consists of a single lens without thickness.

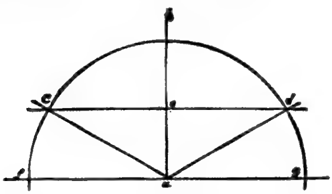

FIG. 7.

If *a b* (Fig. 7), is the focal distance of an objective, and *c d* the diameter of its clear aperture, then its angle of aperture will be *c a d*, and the largest possible working-distance, theoretically, will be *a e*.

If the aperture be the largest possible, it will equal the diameter *f g*; then the angle of aperture will be 180°, and the theoretically greatest working-distance will be *a*, or nothing.

If the diameter of the aperture is *b*, that is, infinitely small, the theoretically largest working-distance will be *a b*, or the focal length of the objective.

These proportions presume the ordinary case, that between the objective and the object there is no other medium than air.

If the space between the objective and the object is occupied by another medium of different refractive power than air, the above proportions will

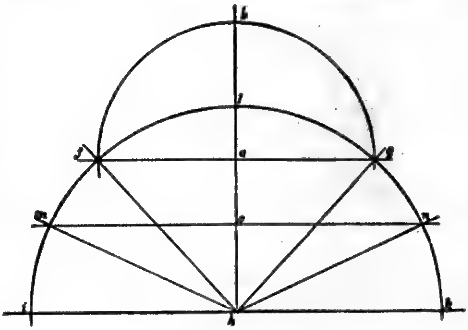

FIG. 8.

be changed. Fig. 8 will illustrate this: Assume that this space is filled with a medium of the same refractive power as glass, such medium as is used with the "homogeneous immersion" objectives. Then if *a b* is, as in Fig. 7, the focal length of an objective in air, and *f g* is the diameter of the clear aperture, and if *f h g* is that "homogeneous immersion-angle" (84°) that is equivalent to the air-angle *f a g* (180°), then the theoretically largest working-distance will be *h a*.

But if the diameter of the clear aperture is increased to *m n*, the angle of aperture will be increased to *m h n*, and the theoretically largest working-distance will be reduced to

h o. The angle *g h n*, or *f h m*, will then, be the so-called exterior or outer angle.

If the diameter of the aperture is increased to *i h k*, the objective will have the theoretically largest angle of aperture in this medium, that is, *i h k*, or 180°; and the theoretically longest working-distance will now be *h*, that is, infinitely small.

If the clear aperture is *l*, that is, infinitely small, the theoretically largest working-distance will be *h l*.

The working-distance of an objective may be expressed numerically, from a comparison of the theoretically longest working-distance as unity, and the result may be called the numerical working-distance.

As a single lens without thickness cannot be produced, the actual working distance of an objective will be much less than the unit of the numerical working distance.

It must not be forgotten that this unit not only depends upon, and changes with, the focal length, but also with the angle of aperture. Briefly stated, the unit of the numerical working-distance of an objective is the cosine of an arc, the centre angle of which is equal to half the angle of aperture and the radius of which is equal to the focal length or the sine of which is equal to the radius of the clear aperture of the objective.

As objectives of the best quality require several lenses, each of which reduces the working-distance, the numerical working-distance tells directly to what extent this reduction of the working-distance has been counteracted by the constructor.

If f is the focal length, a one-half of the angle of aperture, d the *actual* working-distance, n the *numerical* working-distance of an objective, then,

$$n = \frac{d}{f} \div \cos. a.$$

The usefulness of the knowledge of the numerical working-distance of an objective, in determining its comparative excellence, may be understood from the following examples:—

Example I.—If the focus of the objective is one-tenth of an inch, and the angle of aperture 150°, then *a e* Fig. 7, or the theoretically greatest working-distance will be 0.02588 inch; and if the actual working-distance is 0.00525 inch, then the numerical working-distance will be 0.204.

Example II.—If the focus of the objective is one-tenth of an inch, and the angle of aperture only 100°, then *a e*, Fig. 7, or the theoretically largest working-distance, will be 0.06428 inch; and, if the actual working-distance is the same as in Example I, that is 0.00525 inch, then the numerical working-distance will be only 0.082.

Example III.—If the focus of the objective is one-tenth of an inch, and the angle of aperture 100°, and the numerical working-distance the same as in Example I, that is 0.204 inch, then the actual working-distance will be 0.01311 inch.

From these examples it follows:

1. If two objectives have equal focal length and equal working-distance but different angle of aperture, then the one with the larger angle of aperture has the greatest numerical working-distance.

2. If two objectives have equal focal length and equal numerical working-distance, but different angle of aperture, then the one of the larger aperture has the shortest actual working-distance.

3. If two objectives have equal focal length and equal actual working-distance but different angle of aperture, then the one of larger aperture has the greatest numerical working-distance.

4. The actual working-distance of an objective is in direct proportion to the numerical working-distance.

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EDITORIAL.

—This number of the JOURNAL will be sent to many who are not subscribers, in the hope of inducing them to send in their names, and one dollar for the current volume.

Every new subscriber contributes just so much, not only to the support of the JOURNAL, but also toward its excellence and value, by enabling the publisher to spend more money for the illustration of valuable articles. We solicit the support of every man who is a member of a microscopical society. If we could obtain this, we would ask for nothing more.

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—We are often led to regret the narrow scope of our periodical, since it sometimes prevents us from giving reviews of the most interesting scientific pamphlets that we receive. The *Bulletin* (No. 3) of the Illinois State Laboratory of Natural History, at Normal, Ill., which has lately reached us is one of these. The first article, by the able director of the Laboratory, Prof. S. A. Forbes, "On some Interactions of Organisms" gives a general view of the relations that are observed between animals and plants, their food and surroundings. The succeeding articles treat of special divisions of the same subject; thus, we find one on "The Food of Fishes," another on "The Food of Young Fishes," another on "The Food of Birds" and then follow some notes on the "Habits of Predaceous Beetles" and on "Insectivorous Coleoptera."

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BINDING.—Subscribers who wish to have their volumes bound will find an advertisement of Messrs. D. & J. Sadlier & Co., in another place, with whom we have made arrangements as there announced. The binding they have already done for us is both durable and attractive.

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VIBRATILE CILIA IN THE INTESTINE.—In *Zoologischer Anzeiger* we find the following, which seems worthy of careful attention. It is by Dr. R. Blanchard, of Paris:

Several observers have recently proved that there are cells with vibratile cilia in the stomach. I am in a position to add to these observations and even to extend them to the intestines, more especially to the rectum of various animals.

In 1878, during a short sojourn at the University of Bonn, at the laboratory of Prof. Leydig, I had occasion to ascertain, in several instances, the presence of a continuous lining of vibratile epithelium over the entire surface of the rectum of tritons. As in the case noticed by Dr. Max Brown, in *Zool. Anzeiger*, No. 69, this epithelial covering presents the same aspect as that of the pharynx. This peculiarity of structure is shown very well in pieces prepared with osmic acid (1-100).

Doubtless it will not be without interest to remark that this observation was made in the month of May, upon animals captured two or three days previously, and in which the functions of digestion took place with great activity.

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INSTRUMENTS AND THEIR USE.—The *Zeitschrift für Instrumentenkunde* is a new periodical the first number of which has just reached us, and for which we are indebted to the well-known house of B. Westermann and Company, of this city, who are the agents for this publication in the United States.

As its name indicates, the publication is devoted to the description of instruments and instructions for their proper use. It is, so far as we know, the only periodical publication of the kind in the world, and no person can question the real utility of a work "which is exclusively dedicated to the resuscitation of a closer, fruitful intercourse between the representatives of science and those of the mechanic arts, as also to the critique of instruments."

Surely every teacher of science will find this work of great assistance, more especially in the physical sciences it is true, but in other branches it will also be of great value. The number before us contains, besides other articles, a description of the Normal-Barometer and Manometer of the Imperial Commission of Berlin, and there follows a very interesting contribution from Dr. Förster on the "Illumination of the Micrometric apparatus in Telescopes and Microscopes," and a practical article on the "Production and Investigation of Micrometer-screws," by C. Reichel. We must end this notice by a mere reference to two articles relating to the Spectroscope, and one upon "Graphic Methods in Physiology" both of which are well illustrated. To indicate the wide scope of the publication we mention in addition the following articles soon to be published: "The Determination of the Constants of Optical Systems," by Prof. E. Abbe; "Apparatus for Plant Physiology," by Prof. F. Cohn; "Grinding of Optical Glass;" "A New Microscope," by Dr. Hartnack. The parts are issued monthly, and the subscription price is $4.50 per year.

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Ye Microscope of Ye Olden Time.—This is the title of a very interesting lecture delivered by Prof. Edward F. Moody before the Camden, N. J., Microscopical Society, and printed in pamphlet form.

As the pamphlet can probably be obtained from Mr. De la Cour, the Secretary of the Society, we will only refer to it in a few words.

As a frontispiece there is an engraving of an old "double microscope" devised by John Marshall for showing the circulation of the blood, copied from an illustration in the *Lexicon Technicum* published in 1704. The account of observations made with this instrument as given by Prof. Moody is very interesting, and the entire lecture is well-worthy of careful reading, although there are a few misstatements which microscopists will readily detect. We hope the edition is a large one, so that all our readers who desire copies will be able to obtain them; for when we have the great energy and enthusiasm of the microscopists of a century ago thus called to our minds, it should stimulate us to greater application. It is true that then the entire domain of nature was unstudied, and a new discovery rewarded every effort; but it is not so much the great number of observations that interests us, as it is the excellence of the results attained with the imperfect instruments at command. Lewenhoek certainly made very accurate observations with his primitive instruments, and the fame of Ehrenberg, who, although he lived not very long ago, still used very imperfect instruments, rests upon results which can only be verified with the costly apparatus of the present time at the expense of long and patient work.

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Moist Chamber.—Prof. Strassburger's moist chamber is described in the *Journal de Photographie et de Microscopie*, as follows: It consists of an ordinary slide upon which is placed a ring of paste-board, moistened with water. The object which is to be observed and kept alive is placed in a drop of water on a cover-glass and inverted over the paste-board chamber; the cover is made to adhere to the cell by pressure. The evaporation of the drop of water is greatly retarded, if not entirely prevented, so that in this simple manner Prof. Strassburger has kept *Spirogyra* in copulation alive for several days. By moistening the paste-board from time to time the cover will remain attached indefinitely.

The drop of water can readily be covered with a small and thin glass before inverting it over the cell, just as in the slide described on p. 24, by Mr. J. Deby.

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APERTURE AND EYE-PIECES.—The communication of Mr. S. A. Webb, which appears in another column, contains a clear exposition of some of the advantages of large angular apertures for high-power lenses; and not many years ago, all of the assumptions contained in his letter would be fully endorsed by microscopists. But now the case is different. Without wishing to detract from the real value of Mr. Webb's letter, we deem it proper to point out some errors for which, indeed, he cannot be held responsible, since no text-book in the English language contains the results of the latest investigations relative to the physics of vision with the microscope. The subject is too abstruse to be treated in a condensed form, we would otherwise have given our readers a succinct analysis of it some time ago. We intend to do so as soon as we can devote the necessary time to its preparation. Referring now to Mr. Webb's letter, it should be clearly understood that the "differences of light and shade," which he says "define and give us the idea of form," are of no consequence whatever, so far as definition of minute textures is concerned; for, in the case of a diatom like *P. angulatum*, for example, the rays which show these differences of "light and shade" caused by the partial absorption of the light by the less transparent portions of the diatom, may be totally shut out from the ocular, but the fine markings of the frustule will still remain. Only the widely separated and coarse parts of any object, speaking comparatively, such as the outlines, are defined in accordance with the usually received explanation, by the principles of dioptrics. The finer markings are imaged in a totally different way, which we cannot now explain further than by stating that they are only defined when the illuminating rays are decomposed by diffraction, and the objective is of sufficient angular aperture to afterward collect the rays and form them into spectral images. These spectral images may be seen by resolving a coarsely marked diatom with a ⅔-inch objective, then removing the eye-piece and looking down the tube.

These facts also lead to the conclusion that resolution is practically independent of magnification, and that there is a limit of magnification for each objective, or rather for every angular aperture, which enables the eye to see every detail which the objective is capable of defining. As this limit is not very high even for the widest apertures—certainly not over 2,000 diameters—we may well question the utility of very high eye-pieces.

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THE AMERICAN SOCIETY OF MICROSCOPISTS.—The next meeting of this society will doubtless be held at Columbus. An invitation has been received from that place, which will probably be accepted. We will endeavor to keep our readers fully informed of all arrangements that are made for the meeting. We hope none of them will be deterred from preparing articles to read at the meeting on account of the rule that was passed which forbids the publication of such articles until they have appeared in the *Proceedings* of the Society, for we are confident that that rule will not be enforced, even if it should not be rescinded at the meeting.

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ABOUT OBJECTIVES.—Dr. Detmers inquires, in his communication published in another column, whether the flagella of *Bacterium termo* have ever been seen with any low-angled objective.

We are not aware that they have been, in fact, we are quite sure that they have not; but one would infer from the manner in which the question was asked, that we had expressed opinions at variance with the facts. This is by no means correct, and the

careful reader will find nothing in the article to which Dr. Detmers refers (Vol. I, page 217), to justify such an inference. On the contrary, the value of any given angular aperture, for any stated purpose, is capable of accurate mathematical calculation—it is no longer a matter of individual opinion, which, in many cases, is of little value. On the other hand, the question of what objectives are the best for common use is, so far as we know, still purely a matter of experience; and the work in which a person is engaged will greatly influence the decision.

We are pleased to learn that Dr. Detmers has succeeded in observing the flagella referred to; for although others have doubtless seen them, this is the first instance that has come to our notice in this country. If we are not mistaken, they were first observed by Dr. Dallinger, with a Powell & Lealand one-eighth.

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PASTEUR'S FLUID. — Several persons have requested us to give the composition of Pasteur's fluid, which was referred to last month in the report of the Wellesley College Microscopical Society. The fluid used by M. Pasteur was a solution made from the ash of yeast, but a very good substitute, which is usually employed, is composed as follows :—

Potassic phosphate, .	20	parts.
Calcium sulphate, .	2	"
Magnesic sulphate, .	2	"
Ammonium tartrate, .	100	"
Cane Sugar, ...	1,500	"
Water, ...	8,376	"
	10,000	

—o—

CLATHRULINA ELEGANS.—A short time ago we found a number of specimens of this beautiful Rhizopod in a bottle of water in which Rotifers were quite abundant. As the specimens were larger than those described by Prof. Leidy, we give the measurements as they are noted in our book, at the time: Diameter of capsule 43^{μ} -47.5^{μ}, diameter of stem 1.9^{μ}, diameter of openings in the capsule 7.25^{μ}. The pseudopodia were considerably longer than the diameter of the capsule, very straight and clear.

CORRESPONDENCE.

TO THE EDITOR:—In your November number, in an article headed, "About Objectives," the question is asked: "What discoveries or new observations have you made with your fine objectives?" This question I will answer. I have a $\frac{1}{18}$ homogeneous immersion of R. B. Tolles, angle of aperture, in medium of 1.525 refractive index, 114°. It has shown, with a Beck No. 2 eye-piece, on Beck's best stand, the flagella on bacterium termo, and also flagella on the exceedingly small bi-spherical Schizophytæ, which constitute the cause of swine plague. Has any low angled Objective ever done that? Please answer.

The November number contains also a report of a meeting of the Illinois State Microscopical Society, in which I showed a very thin section, cut with a new section-cutter, made by W. H. Bulloch, and devised by Prof. Burrill, Mr. Bulloch, and myself. Your report gives a remark by Mr. Beck, who was present and suggested (sneeringly?) that some of the surplus American ingenuity of the members might advantageously be expended in inventing a section-cutter for diatoms, Mr. Beck made the above remark but for obvious reasons nobody deemed it worth while to reply, and I would not now, if his remark had not been published. If Mr. Beck will kindly furnish a knife that will cut silica it will be a very small affair for American surplus ingenuity to invent a section-cutter for diatoms, and to slice up Amphipleura pellucida so fine, that Mr. Beck will have difficulty to see the sections, unless he uses American objectives.

Very respectfully yours,

H. J. DETMERS.

CHICAGO, Ills.

—o—

TO THE EDITOR:—In your December number, 1880, where I said that I had "tried the new Gundlach $\frac{4}{10}$ with his $\frac{1}{18}$ periscopic ocular, and got "good light and fair definition" you made me say ½, instead of "$\frac{1}{18}$" thinking, I suppose, that

the $\frac{1}{18}$ was a mistake; I meant just what I said, this $\frac{1}{18}$ periscopic has wonderful definition.

But it was not of this that I intended to write; so much has been said about low and high angles, and penetration, that I am inclined, is an *ex-cathedrâ* style, to give my own ideas upon these questions, founded upon my own experience.

First.—Rays of light are radiated, for a space of 180° from each minutest point of an object, that point forming the centre of the circle.

Second.—The rays taken into the objective and transmitted to the eye, proceed, so to speak, like a shower of impulses, to the optic nerve, and if enough of such rays, from each point, act upon the optic nerve, a sensation of sight, and form, or intimate definition is produced.

Third.—This shower of impulses is strong or weak in proportion to the number of such rays taken into the objective and transmitted.

Fourth.—The larger the angle, in proportion to the power of the objective, the stronger the impulse, because of the larger number of rays from each point, reaching and acting upon the optic nerve. (By this, I do not mean a glare of confused rays.)

Fifth.—In low powers, since a large actual field is taken in, very high angles are not needed for ordinary definition, such as might be needed with greater amplification.

Sixth.—In the high powers, having great amplification, definition of each minutest point of the object, is what we seek, and therefore we must have as many of these radiated (not confused) rays as we can. Then, we must have high angles, in order to have our shower of impulses strong, and produce the necessary impression, upon the optic nerve, of the slighest differences of light and shade which define and give us the idea of form.

Seventh.— Up to ½-inch, moderate angles will give us all needful definition for rapid work.

If we wish to see details, we will require higher angles, accordingly.

For both high and low powers, there are three classes of well-corrected objectives, the low, moderate, and high angles, each of these to be used according to our work.

Each of the above classes should be of best quality and corrections, and we find in low and high powers that any objective of either class may be a first-class objective, whether the angle be low, moderate, or high. Of course we might make more classes, but the three cover the ground by extending each class over a number of degrees, until that class meets the next higher in angle.

Resolution, in perfection, is only found in highest angle; perfect correction, or the manner of correction, is not the same for each class. This, it would take too much time to explain, and I leave it, but will instance, resolving objectives, which must be under-corrected, chromatically, to get best resolution.

Every objective must be corrected according to its angle power, and the use to be made of it, and yet each and every class, so corrected, be perfect in its corrections, for the use intended.

Penetration goes hand in hand with moderate angles and perfect correction, and is not the child of faulty corrections.

Best penetration is found in first-class objectives of the lower powers, with moderate angle. Penetration exists in all powers of moderate angle, where perfect correction exists.

As to resolution and penetration, the reasons for the quality, existence and extent of each, would require more room than this article allows, I may give them at some future time.

S. A. WEBB.

OWSEGO, N. Y., Jan., 1881.

NOTES.

—The fifth edition of Mr. Zentmayer's Catalogue of Microscopes, contains illustrations of some of his instruments that were not in the former one. Mr. Zentmayer now makes five styles of microcopes, respectively known as "Centennial," "Army Hospital," "New Model Army Hospital," "Histological," which is now made as a binocular also, and finally a "Student" stand, for which he charges only $38.00. Besides these he has a botanical dissecting microscope, and a pocket instrument.

—Mr. Fr. J. Emmerich, of this City, is now prepared to execute orders for the microscopes and objectives of Mr. Carl Zeiss, of Jena. He expects, before long, to receive a stock of the most salable goods manufactured by Mr. Zeiss, so that he can fill orders promptly, and at the lowest possible price. He can now furnish catalogues in German, and will have

them in English as soon as they can be obtained.

—We have received a circular from the well-known instrument maker, Mr. J. Grunow, of this city, describing a new microscope which he has lately devised, especially for the use of physicians. With one eye-piece and a 1/6-inch objective, the instrument sells for $46. It has a sliding tube for focussing, and a fine adjustment screw.

—Dr. George M. Sternberg, has translated Magnin's excellent work on the Bacteria, and it is now published in English, making a volume of 227 pages with ten plates. We reserve a more complete notice of the book until next month.

—We regret to learn that Dr. J. J. Woodward has met with a serious accident, by the falling of his horse about three weeks ago. His left leg was broken and he will therefore be confined to the house for some time to come.

—We have received from M. A. Booth several specimens of the material which is offered in our "Exchange" column. The diatoms *in situ* are the best we have seen, and they make fine specimens when mounted as opaque objects.

MICROSCOPICAL SOCIETIES

NEW YORK.

The Secretary desires to correct the minutes as published last month, so that the first line on page 19 will read "by Mr. Warnock with a Tolles $\frac{1}{10}$."

At the meeting held January 7th, the President called attention to the method of reproduction of diatoms. Diatoms are minute unicellular plants, which are distinguished from all other plants by very marked characters. The living protoplasm and brownish coloring matter are enclosed in a hard, silicious case, which consists of two distinct valves, corresponding to the covers of a pill-box, with connecting rings, one sliding over the other precisely like the sides of a pill-box. These silicious coverings are often very beautifully carved and marked. It is the silicious remains which constitute the infusorial earths, which are often of great extent. Electro silicon is composed entirely of the remains of diatoms, and they are said to abound in tripoli, but this is not true of all kinds of tripoli. The ordinary process of multiplication in these plants, is by the division of each one into two individuals. Two silicious septa form within the case, and then the smaller valve slides out from within the other, just as the bottom comes out of a pill-box, and each valve maintains an independent existence. A more curious process, however, is by the conjugation of two individuals. They come together and their contents mingle, forming a circular body called the sporange. Within the sporange a so-called auxospore developes, which soon grows so large as to break the sporange, and before long the large auxospore will be seen to contain the young diatom. It is a remarkable fact that the infant diatoms are much larger than their parent forms. It can readily be understood that the above described process of division results in a constant reduction in the size of the diatoms. Hence, the large form which results from conjugation, gives birth to succeeding generations by division, each smaller than its progenitors, and this would continue indefinitely, except for the limit fixed by nature. All these processes take place in organisms so minute that they can hardly be seen with the naked eye, under the most favorable conditions.

ELMIRA, N. Y.

Regular meeting, December 30th, 1880. President Gleason in the chair. The usual members were present and a large number of visitors. Mr. Sexton, of Rochester, exhibited Gundlach objectives and stands to the Society. The American Society of Microscopists was invited to hold the next meeting in Elmira, under the auspices of the local Society. The regular routine of business having been transacted, Dr. Krackowizer delivered a lecture on "Atoms, Molecules, Cells."

He spoke of Atoms having assumed centres of attraction, one, two, three or more, by means of which they were drawn toward one another to form molecules.

He stated that there was no essential, difference between a molecule and the primitive cell, an amœba, for example, chemically considered being but a combination of atoms, manifesting such phenomena of life as locomotion, alimentation, growth, proliferation, etc., sensation and consciousness not being differentiations, but endowments of the higher organism.

"Darwinism" is at present the best working theory, since it more readily explains the greatest number of facts in every department of human knowledge than any other.

Judge Dexter was appointed essayist for the next meeting, subject: Evolution.

After witnessing the circulation of the white and red corpuscles of the blood in a newt's gills, while the creature was confined in a "live box," the Society adjourned to meet again on the last Thursday in January.

THAD. S. UP DE GRAFF, Sec.

CAMDEN, N. J.

At the annual meeting, held January 6th, 1881, the following gentlemen were unanimously reelected officers for the ensuing year:

President, Albert P. Brown, Ph. G.; *Secretary*, Joseph L. De la Cour; *Treasurer*, Louis T. Derousse; *Managers*, A. S. Fortiner, Robert Patterson, C. Henry Kain; *Curator*, Prof E. F. Moody, Ph. D.

The Society numbers 55 members—33 active, 20 contributing, 2 corresponding, and it is in a flourishing condition as shown by the reports of the respective officers.

ROCHESTER, N. Y.

The Rochester Microscopical Society held its annual meeting in the Free Academy building. After the regular routine business, the reports of the various officers, on the work of the past year, were called for.

The Secretary, Dr. J. Edward Line, was first called upon. He reported that the Society had held eight regular monthly meetings during the past year, which were well attended. He presented a list of the papers read before the Society. The second annual Soirée was, in every respect, superior to its predecessor. Some of the statistics of it are as follows:

Number of exhibitors, ...	59
Number of exhibits, ...	132
Number of microscopes, . . .	69
Number of objectives, . . .	96

The membership reported a year ago was eighty-nine. Since then thirty-two have joined the number, while two have been lost, one by death and one by resignation. The total membership at present is 119, of which 110 are active and 9 honorary members.

The President, Professor Lattimore, then made some remarks appropriate to the close of the year and of his official term. In reviewing their past history he congratulated the Society upon the progress it had made. He attributed much of it to the harmonious feeling which had always prevailed. The papers which had been read before the Society had been of exceptional interest. Some of them had attracted a great deal of attention outside of the city. Then, too, the stimulus which the association had given to individual effort was healthful and productive. Their exhibits had changed wonderfully since the first meetings. At first they presented the labor of others, now their own work was exhibited. Some of the work done by members of the Society, in mounting objects, was beginning to attract attention among leading microscopists, and when its full import was known it would attract much more. Professor Lattimore then made two recommendations. The time had come, he thought, when the active working members of the Society should select a field in which to labor. They must narrow their research to one subject. Only thus could they accomplish great results. The details of the work would be mastered and they would be free to observe the more interesting and complex phenomena. He recommended further that the Society subdivide itself into small clubs of three or four members each for pursuing work in the same field togther.

The following officers were elected for the ensuing year:

President: Rev. Myron Adams; *Vice-president*, H. F. Atwood; *Treasurer*, Dr. C. E. Rider; *Secretary*, H. C. Maine.

During the canvass of the votes for president, Professor Lattimore exhibited to the society specimens of trout eggs and shrimps presented by Mr. Enright of the hatching establishment at Caledonia Professor Lattimore suggested a mode of studying the eggs by means of sections made with the section-cutter. During the canvass of votes for vice-president, Mr. Maine exhibited drawings of diatoms from the Massachusetts coast.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Well-mounted diatoms, in exchange for other good slides, material, etc., etc. W. H. TIVY, Sixth and Olive Sts, St. Louis, Mo.

For a slide of Trichina spiralis in pork, send a Histological, Pathological or other well-mounted slide to H. C. DEANE, Box 379, Taunton, Mass.

Wanted—Polycystina, Foraminifera. Diatomaceous Earths, or other material or mounted objects, in exchange for Diatoms *in situ* and free, Diatomaceous Earths, Algæ, and many of the other Cryptogramia showing structure or fructification, and a large variety of miscellaneous material. Only strictly first-class objects offered or desired.

M. A. BOOTH, Longmeadow Mass.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

VOL. II. NEW YORK, MARCH, 1881. No. 3.

Trichinæ in relation to Public Health.

[The following article is an abstract of a report to the Massachusetts "State Board of Health, Lunacy and Charity" (1879), by Dr. F. S. Billings, M. V., which embraces the results of original investigations by the author. For the illustrations we are indebted to the courtesy of the gentlemen composing the Board.—ED.]

The literature treating of *trichinosis* or *trichiniasis* is of comparatively modern origin; but we have no reason to doubt that the disease prevailed in swine at a very early date, and the consequential disease in man must have existed for years, if not for centuries, before it was recognized, perhaps dating back as far as the use of pork as food.

"*Trichina spiralis* is an extremely minute nematoid helminth, the male in its fully developed and sexually matured condition measuring only one-eighteenth of an inch, while the perfectly developed female reaches a length of about one-eighth of an inch; body rounded and filiform, usually slightly bent on itself, rather thicker behind than in front, especially in the males; head narrow, finely pointed, unarmed, with a simple, central, minute oval aperture; posterior extremity of the male furnished with a bilobed caudal appendage, . . . female stouter than the male, bluntly rounded posteriorly; . . . eggs measuring $\frac{1}{1870}$ of an inch from pole to pole; mode of reproduction viviparous." *

These parasitic pests assume two forms, *i. e.*, they may be met with as intestinal trichinæ and as muscle trichinæ, the first representing the sexually matured, the latter the embryonal (usually capsulated), stage of their existence. In order to offer even a very condensed sketch of the evolution which these parasites undergo, it is better to begin with the non-matured, or muscle form. The parasite, in this stage of development,

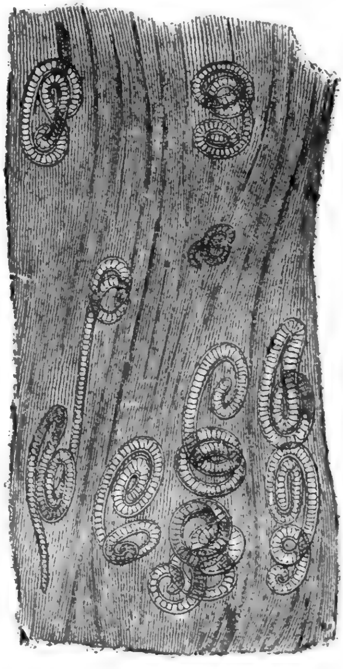

FIG. 9.—Fresh Trichinous invasion. (Heller.)

limits its abode entirely to the striated or motory muscles. They have not been found in the non-striated or involuntary muscles, nor in the purely adipose tissue. The capsulated parasites may be met with in the striated muscles of all parts of the body; the heart seems, however, to be exempt,

* Cobbold, Entozoa, p. 335.

for they have been found in its tissues only in isolated cases (Leuckart, Fiedler).

These parasites are not equally distributed over the muscular system, but, on the contrary, seem to have their favorite places of abode. They appear to have a predilection for the muscles of the anterior part of the body. Among these, those of the tongue, larynx, pharynx, eye, and masticatory muscles are especially favored. The muscles of the body are more frequented than those of the extremities. Very few are found in the

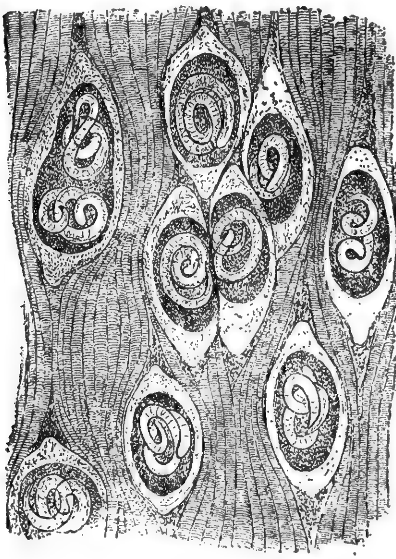

FIG. 10.—Normal encapsuled Trichinæ. (Leuckart.)

inferior portion of the tail of any animal. In the extremities, the parasites are found to be more abundant where the muscle-fibres begin to lose themselves in their tendinous extension, than in the body of the muscle. The following interesting and valuable statistics, with reference to the dispersion of the trichinæ over the organism, are taken from the *Mittheilungen aus der Thierärzlichen Praxis im preussischen Staate*, 1877–78, p. 99.

Eighty preparations from hog No. 1 gave the following results :—

a from the pillars of diaphragm,	12 trichinæ
b from the muscles of diaphragm,	4 trichinæ
c from the laryngeal muscles, .	1 trichina
d from the intercostals, .	no trichinæ
e from muscles of the tongue,	
f from muscles of the neck,	
g from muscles of the eyes and humerus.	

Leuckart estimates that in some of the cases which have come to his observation, a single gram (fifteen grains) of flesh lodged from twelve hundred to fifteen hundred trichinæ. Assuming the muscles of a man to weigh forty pounds, the number of these parasites infesting a human organism, at such a ratio, would sum up some thirty millions. In Zenker's case,—to be noticed later,—Fiedler calculated that the woman lodged some ninety-four millions ; and Cobbold assumes that a hundred millions may sometimes infest one organism at the same time.

In seventy specimens weighing one gram, Rauch found three hundred and fifty trichinæ, at that rate one pound would contain a hundred and seventy-five thousand, and, if the flesh of a hog weighs a hundred pounds, it would, at such a percentage, contain seventeen million five hundred thousand trichinæ. In many cases, however, the parasites, are much less frequently met with ; and one has to search through many microscopic preparations before meeting any, and then only isolated examples.

The calcification of the capsule begins about the fifth month after the invasion of the muscles. In the ordinary pork which is generally offered for inspection, this is not the case, sufficient time not having elapsed for the calcifying process to take place, and the parasites, or, more correctly speaking, the capsules, are not to be seen with the naked eye, a magnifying power of fifteen to twenty diameters being sufficient to their recognition by the practised observer ; but for exact inspection a

power of fifty to seventy-five diameters is always to be preferred. The capsules do not always present the same form to the eye of the observer; sometimes they are well elongated; while at others they are more round, the usual extenuations at the ends being almost entirely wanting. Their average dimensions may be said to be 0.4 millimetre in length, and 0.26 millimetre in breadth. They not infrequently contain two, and sometimes three, parasites.

So long as the trichinæ are in their capsules in the fibre of the muscle, their condition remains unchanged except to die or degenerate after the lapse of a long time; they make no progress in their development. They have been seen in an active condition,—*i. e.*, capable of progressive development under suitable circumstances, yet encapsuled,—thirteen, twenty, twenty-four years, from the time at which their invasion had taken place.

Virchow relates a case, where, after the lapse of thirteen and one-half years, the parasites moved in their capsules on prolonged exposure to the heat of the sun.

Professor Damman, reports an interesting case of the longevity and encapsuling of trichinæ in the muscles of a pig. This hog was fed by Von Behr, in Schmaldow, with trichinous pork in November, 1864. Since that time the animal had been kept isolated in a pen of its own, unless taken out for examination. On the 3d of February, 1875, and 20th of February, 1876, he removed a small piece of flesh from the muscles near the shoulder. In both cases the microscopic examination demonstrated the presence of trichinæ. Rupture of the capsule and the application of moderate heat demonstrated that they still lived. In this case we have unquestionable proof of the presence and continuance of living trichinæ capable of development for a period of eleven and one-quarter years from the time of the infection of the swine.*

Although the capsulated trichinæ suffer no changes while confined in the muscles of a living organism, yet the introduction of portions of such muscles into the intestinal tract of man, or other suitable animal, causes rapid changes in their condition. The processes of digestion soon set the embryonal parasite free from its capsule, three to four hours being sufficient for the purpose; the freed parasites rapidly complete their development, becoming matured trichinæ. Thirty to forty hours are in general sufficient to complete this metamorphosis. In cases of fresh invasion, when the capsules have not become hardened to any great degree, twenty-four hours have been found sufficient to demonstrate the presence of sexually matured trichinæ in the intestines of animals fed with

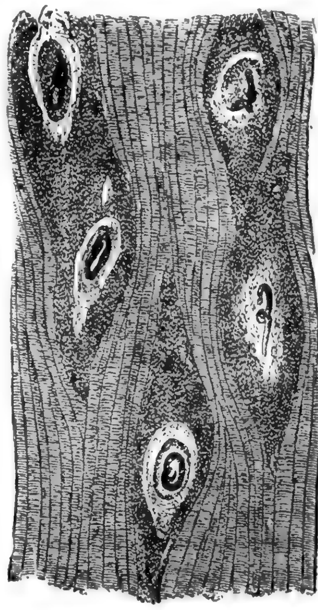

FIG. 11.—Pathologically changed Trichinæ-capsules. Trichinæ dead. (Leuckart.)

*_Zeitschrift für Theirheilkunde_, Vol. III, p. 92.

such flesh by way of experiment. Nevertheless one often finds parasites still enclosed in their capsules on the third day after feeding such flesh to an animal. There is scarcely another worm in which the matured stage is reached in so brief a period. Under these circumstances it must be evident that the changes necessary to maturity for these parasites are not very great. As a rule, sexual connection takes place within two days from the time the trichinæ become free. The parasites increase in length and thickness, and, in the female, the uterus fills with fructified ova, which soon develop into embryos enclosed in the body of the female. Leuckart states that the female intestinal, or matured parasite lives from five to six weeks, and produces at least fifteen hundred embryos. In the intestines of the animal invaded, the females greatly predominate over the male parasites. The newly-born embryos are at first buried in the mucus which lines the intestinal tract, as free and movable parasites. They soon, however, begin their migration and dispersion, the first act being the penetration of the intestinal walls. It seems still to be a matter of discussion, as to the means or ways by which further migration takes place. Some authorities, and among them the most eminent, as Leuckart, Furstenburg, and Gerlach, favor the view that the parasites proceed by way of the mesenterium and connective-tissue tracts over the system, and penetrate the sarcolemma, or connective-tissue membrane of the muscular fibres, to lodge in the substance of the same. Here the parasite develops a capsule or bed of finely granulous character for itself, the sarcous elements of the fibres of the muscles becoming wasted, or used up, and their striation lost so far as the capsule of the parasite extends. The sarcolemma of the muscle fibres forms a thickened secondary capsule around the parasite.

Another view, the possibility of which is conceded in a minor degree by the above-named authorities, is that the parasites gain access to the circulation, and are transported over the system by the moving fluid, boring through the smaller vessels at convenience, and by this means gaining access to the muscular tissues.

Thus it is evident that the consumer of trichinous flesh provides the means for its own infection. While this is in general the manner by which infection takes place, it by no means excludes the possibility of the infection of an animal by intestinal trichinæ which have passed from an already infected organism with its fæces. In this way an infected swine may infect others, or in fact give occasion to a secondary infection of itself, by rooting in the manure of its pen. In the same way swine may become infected from infected men when, as is too often the case, the out-houses for the family are placed over the piggery, or lead into it, or where the contents of the same are thrown into the piggery for the swine to work over. Thus we see the cycle of infection may frequently continue from swine to man, and from man to swine.

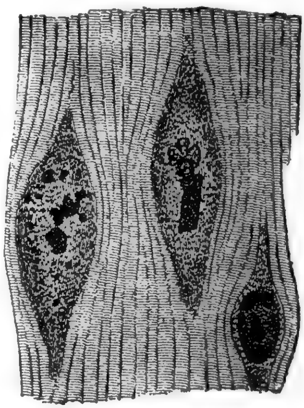

FIG. 12.—Encapsuled concretions with dead Trichinæ. (Leuckart).

[It appears, from a table which ac-

companies the report, that of 2,701 swine examined, 154 were infected with Trichinæ, or one out of every 17.54. Of 89 freshly pickled tongues, 3 were trichinous, but in these the worms were all dead. Health Commissioner De Wolf, of Chicago, found 8 out of 100 swine trichinous.—ED.]

According to the statistics with reference to trichiniasis among swine, it is evident that there is an enormously greater percentage of trichina-infected swine in this country than in Germany, if their statistics can be relied upon. It should be remarked, however, that our investigations were made with very great thoroughness, and that those portions of the swine were examined in which trichinæ are most commonly found. It has been ascertained, too, in Germany, that the percentage of hogs reported trichinous is increasing in that country (*Deutsche Vierteljahrsschrift für öff. Gesundheitspflege*, Vol. V, p. 638).

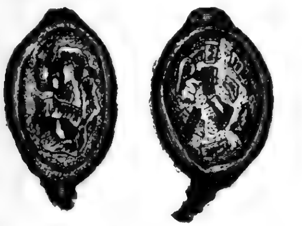

FIG. 13.—Trichina-capsules, with calcified and disintegrated capsules. (Leuckart.)

There is no doubt that the greater part of the swine which I examined were from the West ; yet no one well acquainted with the circumstances would, I think, assert that the general hygienic conditions under which our Western swine are raised are not superior to those of the famed "home-fed porkers" of the small New-England farmer, raised, as they are in only too many instances, in dark, loathsome, poorly-ventilated pens, only too frequently under stables, with the house-vaults and sink-drains emptying into them. Again, whoever has been upon a tour of observation among the agricultural districts of Germany must have been most forcibly struck with the absurd non-hygienic conditions under which not only hogs, but the majority of the domestic animals, are raised and surrounded, in comparison with those of our own country, especially of the great stock-raising West.

With reference to the disease itself among swine, I have taken the following from the *Magazin für die gesammte Thierheilkunde*," Vol. XXXI, p. 6 ; being a report written by Professor Müller of the Royal Veterinary Institute at Berlin, with reference to the results of a long-continued series of feeding-experiments with trichinous pork upon swine themselves. These experiments have demonstrated the fact that the consumption of trichinous flesh by swine, with the consequent development of the embryos in their intestines, and their migration and lodgement in the muscles, may indeed cause disease, but the symptoms of the same have neither that constancy nor character which will admit of their being considered as peculiar to this disease alone, during the life of swine so infected. All the swine which were fed with the trichinous flesh became ill within a few days after its consumption. The most constant phenomena presented were as follows : diarrhœa, not constant, but interrupted frequently by the passage of more solid fæces ; appetite irregular, sometimes more, sometimes less, sometimes entirely wanting ; indications of abdominal pains ; turgidity of the lining membrane of the eyelids.

These symptoms, either singly or collectively, may appear in swine, or any other animal, entirely aside from any trichina-infection : most of them are simply evidence of the irritation caused by the parasites in the intestinal canal. Hence swine dying or killed at this stage of the invasion would present the same pathological phenomena as those suffering from an intestinal catarrh of like grade.

As the migration of the embryonal trichinæ gradually ceases, so do these abdominal phenomena relax in their severity, and finally disappear, unless a second invasion takes place. The invasion of the several muscular systems is indicated by pain, swelling, and disturbance of the motor functions. If these do not lead to death by exhaustion, they in their turn gradually cease with the encapsuling of the trichinæ.

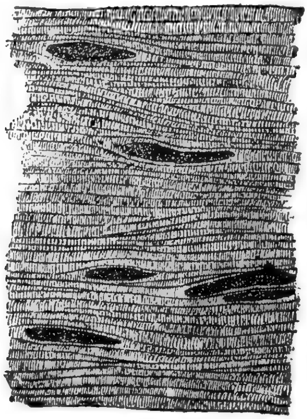

FIG. 14.—Psorosperms in muscle of swine. (Leuckart.)

The experiments of Prof. Leisering, of the Royal Veterinary Institute at Dresden, entirely agree with the above. He says (*Bericht über das Veterinär-Wesen im Königreich Sachsen*, 1862, p. 188), "One cannot speak of a trichina-disease in swine, which is characterized by distinct and pathognomonic phenomena. In this relation, the trichinæ deport themselves in a manner similar to the cysticerci (measles). Leisering made some feeding-experiments with trichinous flesh by a horse, but the most exact examinations failed in discovering a single parasite in his flesh. It may also be casually remarked that fowls present some unknown hinderance to an invasion of their flesh by embryonal trichinæ. I made quite a number of experiments with hens, feeding them for two weeks almost entirely upon pork profusely infected, but was unable to find a single trichina in their flesh.

How do swine become infected under the natural order of things? or, in other words, whence do they derive the trichinæ? That the parasites gain access to an organism by means of the mouth and alimentary canal, is placed beyond all doubt. Notwithstanding the apparent negation of the above-quoted Berlin experiments, other authorities affirm, from positive observation, that the intestinal and embryonal trichinæ do leave the invaded animal with the fæces, as is attested to by such observers as Leuckart, Vogel, Kuhn, Gerlach, and others. It is this form of migration, which under favorable circumstances also contributes to the distribution of the trichinæ. In fact, Haubner and Gerlach mention cases where they intentionally caused infection of young non-infected swine, by placing them with those known to be infected. Such embryos and pregnant females become mixed with the manure and bedding of the hog-pen, and may be taken up by any swine, even by those first invaded, thereby leading to a second infection, self-induced. Of all animals in which these parasites have been found, none have that interest to the hygienist and experimental pathologist which is enjoyed by the rat, on account of a hypothetical ætiological connection between the trichinæ which have been found to infest them in large numbers, and those of swine. Leisering is the originator of this hypothesis.

Forty rats caught at one of the large pork-packing houses near Boston were all found trichinous. Of 60 rats caught for me at different stables in the city of Boston, where no hogs were or had been kept, but six were found trichinous.

The results of these examinations are sufficient to strengthen my scepticism with regard to the rat-infection theory, and seem to indicate that the rats get the disease from eating pork,

or from the swine, and not the swine from the rats. If this is true, we are no nearer solving the question as to how swine become infected, than we were before the trichinæ were found in rats. Some hog-keepers say that they have seen swine hunt and kill rats, while others assert that such a thing never takes place; but they all admit that a hungry hog would undoubtly eat a rat if it had it. Admiting that hogs may become infected from eating a trichinous rat, we have still before us the questions :—

1. Is this the only source from which swine become infected? 2. Is there no common source from which not only they, but wild animals, especially omnivora and carnivora, may become infected?

As American pork, and, according to my observations, American rats, are much more infected than similar animals in Germany, it seems as if here in America were the place to decide these important questions.

THE MICROSCOPIC EXAMINATION OF PORK.—Numerous elaborate essays have been written upon this subject, but the entire process is so easy and simple that such extended labor can well be looked upon as useless. Almost the first, and at the same time by far the most profusely infested muscles, are the so-called "pillars of the diaphragm." The same are to be always found, as two small stumps of flesh immediately above the kidneys in the dressed hog, when hung up to "cool out." If there is a single trichina in the organism, it is probably to be found there. These pieces belong to the trimmings, and are always to be had without in the least disturbing the appearance of the hog. The next step is, to take the piece of muscle to be examined, and, if at all dried, to make a fresh cut into its substance, then with the curved scissors cut one, two, or three thin slices lengthways to the fibres, *i. e.*, with them, and with a needle place them upon the object-glass a little distance apart; the covering glass is then placed upon them, and gently pressed with a slight rolling motion in one direction and back if neccessary. This will make the sections thin enough for examination. The free trichinæ, as shown in Fig. 9, are seldom found in swine, as they are not often examined after a fresh invasion.

To determine if the trichinæ still live, place the object-glass over a spirit-lamp, heat a second, and then place again upon the microscope, and they will be frequently seen coiling themselves in their capsules. It is better, however, to finely tease out the preparation first, when individuals will frequently become freed from their capsules, and their movements can be better observed by the application of heat. Salted pork is best examined by taking the cuts from the scissors, and soaking them in fresh water for a second or so before placing upon the slide. They press out much easier and thinner, when such a procedure is resorted to.

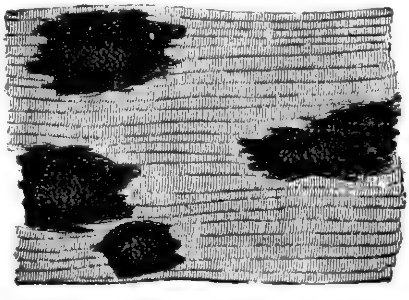

FIG. 15.—Deposit of Tyrosin crystals in ham. (Leuckart.)

OBJECTS WHICH MAY BE MISTAKEN FOR TRICHINÆ OR NOT RECOGNIZED AS SUCH.—There are some possible sources of mistake in examining for trichinæ, as indicated below, but which can readily be avoided with care. It not unfrequently happens that the capsules of the parasites formed by the sarcolemma, or embracing membrane of the muscle-fibres, become abnormally thickened, the trichinæ being

dead within them. These capsules do not present exactly the same appearance as under normal circumstances, as may be seen by comparing Figs. 8 and 9.

In other cases the calcification is of such a character as to almost entirely change the appearance of the capsules and contents (See Figs. 10 and 11).

In some cases *cysticerci* (measles) perish and become calcified; but these formations are very much larger than those of trichinæ, and are often filled with a caseous mass. The "sacks of Rainey," or, as they are sometimes called, "psorospermia," (Fig. 12) are elongated bodies, like the trichinæ, situated within the sarcolemma, the true nature and pathological importance of which are not yet well determined. Some of the points distinguishing them from trichinæ are, that by the latter the striation of the muscle-fibre, or better the plasma, sarcous elements, is destroyed within that part of the sarcolemma which is included in the capsule of the trichina: by the psorosperms, however, it is retained, and only displaced by the object itself, limiting it on each side, and continuing directly from its poles. Bruch, Virchow, and Leuckart have described peculiar roundish or oval masses of a whitish color, of variable dimensions, which occasionally appear in the flesh of hams. The same have been microscopically demonstrated to consist of agglomerates of needle-like crystals (Tyrosin, Fig. 13). They fill the muscle-fibres to a variable degree, without otherwise disturbing its structure, and disappear upon treatment with muriatic acid, the normal transverse striation again becoming apparent.

Trichinæ in Man.—It has been previously stated, that for some thirty years subsequent to the first description of the capsule by Hilton, and some twenty-five years after the identification of the parasite itself in man, the same were looked upon as mere harmless curiosities, and, that, although Leidy discovered the parasite in the flesh of swine in 1847, still it was not until 1860 that the connection was established between them, appearing, as they had, in two totally different species (men and swine). The honor of this important discovery belongs to Dr. Zenker of Dresden, Germany. The disease was discovered in a servant-girl admitted as a typhus patient to the City Hospital in Dresden. She died, and her flesh was found to be completely infested with trichinæ.

Leuckart's and other experiments have shown that a temperature of 140° F. is neccessary to securely render trichinæ inert. Direct heat applied to the slides holding specimens of trichinous pork, by means of the Schultz heating-table, has demonstrated, under the microscope, that a temperature of 50° C. (122° F.) is necessary to the certain death of the trichinæ.

Leisering's experiments with trichinous pork, made up into sausage-meat and cooked twenty minutes, gave positive results when fed to one rabbit, and negative by another. He sums up his experiments as follows:—

1. Trichinæ are killed by long-continued salting of infected meat, and also by subjecting the same for twenty-four hours to the action of smoke in a heated chamber.

2. They are not killed by means of *cold* smoking for a period of three days, and it also appears that twenty minutes cooking freshly prepared sausage-meat is sufficient to kill them in all cases.

The various kinds of cooking, however, are quite different in their effects on trichinous pork. Frying and broiling are most efficient, roasting coming next. Boiling coagulates the albumen on the outer surface, and allows the heat to penetrate less readily; it should be kept up therefore for at least two hours for large pieces of meat. Whether boiled, broiled, or fried, pork should always be thoroughly cooked.

Practically speaking, the cooking, salting, and hot smoking which pork in its various forms receives in the United States must be in the vast majority of cases sufficient to kill the trichinæ, and prevent infection of the persons consuming the meat. Epidemics like those reported in Germany are unknown here, and trichiniasis in a fatal form is undoubtedly a rare disease. In the vicinity of the great pork-packing establishments near Boston, the "spare-ribs," containing the intercostal muscles, are very largely bought and eaten by the people near by; and trichiniasis among them has not in a single case been reported, so far as I have been able to learn. The *cuts* being thin and well cooked, any trichinæ in them are quite certain to be killed. Even when trichinæ are introduced into the intestinal canal, too, they are sometimes expelled by diarrhœa, and the invasion of the system by a small number does no harm.

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Monobromide of Naphthaline and Wax-cells.

I send the following extract from a letter received from Herr Weissflog, of Dresden, which will be interesting to many of your readers. I have not used the monobromide of naphthaline yet myself, but am now preparing some. The slides sent by Herr Weissflog show that there is very little difference in regard to the visibility of small transparent diatoms, like *A. pellucida*, and *Rhiz. styliformis*, between dry mounts and those in the monobromide.

The frustules of *P. angulatum* are, as every one knows, very transparent, sometimes almost invisible in balsam; but in the monobromide mount, the markings are as readily seen as on the dry frustule, and also the same peculiar color of the dry valve, and the *Amphipleura pellucida* is quite as distinct and easily resolvable as in a dry mount. If the use of the monobromide will enable us to dispense with the preparation of cells for dry mounts, even for diatoms alone, and ensure their permanancy, it will be a great step in the right direction, and I hope the subject will receive careful and earnest attention.

H. L. Smith.

* * * You already know that monobromide of naphthaline has been proposed for mounting diatoms instead of Canada balsam, and I have for some weeks been experimenting in order to obtain the proper preparation. I send to you to-day three slides, viz.: *Amphipleura pellucida*, *Rhizosolenia styliformis*, and *Pleurosigma angulatum* thus prepared. The distinctness of the diatoms as compared with the balsam mounts, is very great and is especially noticeable in *Rhizosolenia*.

I have read with much interest your articles on wax-cells; these, in my opinion, must be thrown aside. I have quite a number of preparations from Eulenstein which are made with wax-cells; they are completely spoiled, and the covers are loosely attached, and easily removed.

Herr Lindig of this place, who has had much experience in mounting microscopical preparations, and has for many years sought to find some reliable cement, has arrived at the result that shellac is the best, and he now uses nothing else. I am decidedly of the opinion that the spoiling of preparations is partly due to the glass. I have slides of the best plate-glass, and when they are packed away, the outer surface appears after a time, covered with moisture, and I have noticed a similar effect on a micrometer eye-piece from Ross, of London; I also agree with Mr. Kitton, that the covering glass can work harm. I have for sometime used glass of Chance Bros., and have often found numerous crystals which appear to come from a kind of sweating, or decomposition of the surface. * * *

E. Weissflog.

Dresden, January 21st, 1881.

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An Ideal Series of Objectives for Microscopical Work.*

[Governor J. D. Cox, of this city, recently wrote a leading microscopist on the subject of an ideal series of objectives for microscopical work. His correspondent, regarding the views of value, submitted them, we understand, to Prof. Abbe, of Jena, hoping he might make formulæ for such a series, to be worked out under his supervision by Zeiss. At our request, the Governor has given us that portion of the letter in which he discusses the subject for publication, which we here present to our readers. —Ed. *Med. News.*]

"Prof. Abbe's enunciation, in a recent article, of the proposition, in substance, that one great objective of a given angle of aperature should, if properly constructed, do all that *any* glass of that aperture will do, strikes me with peculiar force, because I have been leaning to that view myself. It amounts to this, viz.: Angle of aperture determines the power of discriminating minute variations of structure, or of surface in the plane which is in focus; *ergo*, if the objective is thoroughly well corrected, eyepiecing will do nearly all that increase of power in the objective would do, without increasing or widening the angle.

"A practical suggestion grows out of this, which, if it could be carried out by Zeiss under Prof. Abbe's directions and with his formulæ, would be of interest to the microscopical world. It is, that the true model for a series of objectives, would be a list containing the lowest powers that can be thoroughly well made of each of the desirable angles which will combine maximum aperture with low magnification. The series would thus be scientifically progressive. We should then only need to select those which would combine the most desirable *working-distance* with other qualities, and the model series would be complete.

"Besides the lowest powers, we should want one objective of 40° angle for use with the binocular upon opaque objects. We should want a glass, with nearly half an inch actual working-distance, for use with dissecting instruments or with the mechanical finger. Another, with an eighth or a tenth of an inch clear working-distance, would be needed for rough examinations of algæ, etc., in the common animalcule cage or compressor, with pretty thick cover glasses. The problem is, What is the *highest angle* consistent with these conditions? Indeed, I do not see why we should not rate our glasses by the angle of aperture rather than by the so-called focal distance, for we should always know what a thoroughly corrected glass of a given angle *ought* to do; whereas, nobody knows what a glass' performance will be, because it is called a "quarter" or an "eighth," under the present nomenclature.

"In further elucidation of the matter, it may be well to refer to the tables which the Royal Microscopical Society have publised and kept standing in their journal. These tables are based upon Prof. Abbe's notation, and show the resolving and defining power of objectives of various angles, theoretically calculated from Abbe's formulæ. They give, of course, the *possible* performance of glasses, to which objectives will approximate according to the perfection of their corrections and finish. It is easy to see how a series of glasses, constructed upon the conditions which have been stated above, may combine maximum performance in each department of work, with the minimum number of objectives. Thus, the scientific outfit of the microscopist would be made at once, least cumbersome in quantity and most efficient in quality. In this way, we should have what might fairly be called an ideal series of lenses.

In practice, the result would be somewhat as follows, viz.: 1. An ob-

*From *Cincinnati Medical News*, January 1881.

jective of 40° aperture and half an inch working-distance, giving about forty diameters' magnification with the ordinary No. 1 ocular, and resolving 38,000 lines to the inch; 2. An objective of 100° aperture and one-eighth of an inch working-distance, giving about 120 diameters' magnification, and resolving 70,000 lines to the inch; 3. A homogeneous immersion objective of 120° balsam angle of aperture, giving about 300 diameters' magnification, and resolving 120,000 lines to the inch. Proper eye-pieces would make these three objectives cover the intermediate magnifications desirable, and the third objective in the list would resolve any test resolved by any glass yet made and in the market; whilst the 40° glass would give all the "penetration" needed for the binocular with opaque objects.

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Detection of Starch-glucose in Sugar.

[The adulteration of sugars with starch-glucose is extensively practiced, and various methods have been devised to detect the fraud, but none of them are so simple as the one described by Mr. Casamajor in the following letter.—Ed.]

Last evening, at the *Conversazione* of the Chemical Society, I showed how easily the adulteration of sugar by starch-glucose, can be detected by the microscope.

I had two samples of coffee-sugar, one being a pretty high grade sugar, and the other being of as low a grade as there is in the market; I had, besides, a sample of the starch-sugar in small grains, which is used to adulterate sugar, and also a sample of adulterated sugar, "new process sugar," so-called.

Both the samples of coffee-sugar, when seen by reflected light through an A eye-piece and a $\frac{4}{10}$ objective present a beautiful appearance. Every crystal is perfectly formed and thoroughly transparent. A group of these crystals looks like a mass of rock-candy.

The grains of starch-glucose are opaque and look like pieces of tallow.

In the adulterated sugar, the crystalline grains of real sugar and the opaque, amorphous grains of starch-sugar may be seen side by side with great distinctness.

I send you herewith samples of coffee-sugar, also samples of starch-sugar and of the adulterated sugar, that you may see them for yourself.

P. Casamajor.

Brooklyn, Feb. 22d, 1881.

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The Preparation of Vegetable Sections.

There are few mounted objects that are more attractive than well-made preparations of vegetable tissues, and there are none more easily prepared. The symmetrical arrangement of the cells as shown in a cross-section of a stem often makes a beautiful object, but even this can be greatly improved by double staining. For the ordinary purposes of the microscopist the cell should be freed from their contents of protoplasm, starch, etc., but for some purposes, as in the study of cell growth, for example, it is necessary to retain these constituents. It is intended to describe in this article only the process of preparing the specimens with the cell-contents removed.

Select stems or leaves of a suitable size, and if the former are tough or hard, soak them in water to soften them. Leaves should be placed in alcohol if they are not to be immediately cut, but stems of hard wood may be preserved dry; the softer kinds should be placed in alcohol. They may be tied in a small bunch with a piece of thread and a slip of paper with the name written with a pencil attached, and several such bunches may be preserved together in a bottle of alcohol.

The first operation is to cut the sections, and, as the methods for doing this are well described in the element-

ary books it is not deemed necessary to describe them here. It may be said, however, that only perfect sections should be preserved, and as a rule these should be as thin as the tissues will cut without injury to the cells.

The good sections should be placed in alcohol and allowed to remain in that fluid for a day or two, in order that resinous matters may be removed, after which, if they are to be stained they must be bleached. If, however, it is intended to mount the sections without staining them, they should be transferred to clean and strong alcohol, then to oil of cloves, or to oil of cajaput which is cheaper and quite as good, and then mounted in balsam.

The bleaching may be effected in several ways, the one most commonly employed is by means of Labarraque's solution of chloride of soda, which can be obtained from any druggist. The sections should be placed in this solution until they become quite white, after which every trace of the solution must be washed out with clean water. The Labarraque solution destroys the protoplasm and nothing remains but the cell-walls. Another process of bleaching sections is given on page 8 of Vol. II of this JOURNAL.

The processes for staining are numerous, but in this, as in many other things, the simplest and most readily followed method gives results quite equal to any methods that have been proposed. If the reader will refer to the process given on page 81 of Vol. I of this JOURNAL, he will find one that has succeeded well, we believe, in the hands of every person who has tried it, and the colors are certainly very brilliant. All the other methods that we have tried have presented greater difficulties than this one, which, indeed, is quite simple.

It is advisable for the novice to begin with specimens that are well adapted to double staining, such as the softer stems with large cells, in which hard and soft tissues are quite distinctly defined, for with the hard woody stems it is often difficult to obtain excellent results without considerable experience. Nothing is more satisfactory to begin with than a stem of the pond-lily. Sections of leaves are to be treated precisely like sections of stems.

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Form-cycle of Glœocystis.*

BY PAUL RICHTER.

(*Continued.*)

In the long cylindrical cells, as long as 12μ, which are usually enclosed in a cylindrical envelope, and which I have, as already indicated, taken for *Glœocystis monococca*, Ktz., a cross or diagonal division into two daughter-cells takes place, which become spherical and remain at the ends of the cell. Soon these surround themselves with a special envelope, and repeat the division. By the softening and extending of the mother-cell wall, the succeeding generations of cells all remain within one envelope, and in this manner produce the forms of *Glœocystis vesiculosa*, Näg., the further description of which would be superfluous. In the spherical cells there is frequently seen a one-sided arrangement of the chlorophyll, as was also observed in the cylindrical forms, so that the question arises with me, whether it is necessary to establish a new species. Notwithstanding the circumstance that I find this *Glœocystis* so frequently in moist forest ground and in similar places, it may still be that it is a known species, in which this one-sided arrangement of the chlorophyll has been overlooked. Otherwise it agrees with *Gl. vesiculosa.*

In its further course, from this *Glœocystis* comes a *Palmella* form, which, if only a thin general envelope was to be seen, would agree perfectly with *Glœocapsa stillicidiorum*, Ktz., *Tab. Phyk.* I. T. 20. The envelopment, and forming of special envelopes ceases, the daughter-cells lie free in the mother jelly and repeatedly di-

* Translated from *Hedwigia.*

vide into tetrahedra, so that mulberry like cell-colonies are produced. The general envelope becomes liquefied, so that only thin circular borders can be seen. The size of the single, finally spherical cells, was different; I measured diameters of 3—7μ. Division occurred in cells of every size.

Finally, the formation of these tetrahedra also ceased; from them the enveloped *Glœocystis* form was produced. Single, special vesicles, however, produced the spherical cells in cylindrical envelopes, which increased in size, escaped, and reproduced the form from which I started. In this generation I observed the already mentioned division into four parallel cylindrical daughter cells, placed in the direction of the axis. Cells which did not divide, swelled greatly, up to 10 in diameter, and bore on the surface of the walls a short, conical projection. A process of copulation, which I expected to observe here, did not take place. The chlorophyll-contents of these cells, had accumulated in an elongated ball upon that part of the cell-wall opposite to the projection, the plasma occupying the rest of the cell was turbid and granular. Finally the entire contents escaped by the solution of the enclosing membrane. The chlorophyll balls did not break up, but I observed them half a day or more and detected a fine membrane around them. They were not followed any further.

In *Glœocystis rupestris*. Rab., which I have frequently found this Summer on rocks in moist forest ground near Dresden, I have likewise observed that free, or naked, cylindrical cells belong in the form-circle; these are, as already remarked, *Palmoglœa lurida* and *rupestris*, Ktz. It is to be hoped that the form-changes of *Gl. fenestralis*, Al. Brann, may also be made out.

According to my observations, it appears that in *Glœocystis* there is a form-series of cylindrical cells, which may be either enveloped or free, which alternate with the common spherical and enclosed cells, and that within this latter series there is a *Palmella* condition with tetra-division.

Likewise the *Palmoglœa* species, in which no copulation was observed, and which, therefore, fits in no particular place, has found its position; for it may be assumed that for those not here mentioned, in case they are not identical with those placed in the form-circle of *Glœocystis*, similar relations will be found.

I remark still, that I have not only derived the *Glœocystis* form from the *Cylindrocystis* form, but I have also collected, especially in forest-ground and on masonry, the *Palmella* condition and the true *Glœocystis* form, from which I saw the *Cylindrocystis* form develop. It now remains to establish the synonyms for *Glœocystis*, which I suppose to be *Glœocapsa*, *Cylindrocystis* and *Microcystis*.

After long rains, one will have good opportunity to collect the *Palmella* condition, in mountainous places, and to control my observations.

LEIPZIG-ANGER, October, 1880.

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Photographing Bacteria.

In the *Zeitschrift für Mikroskopie* there is a short article on this subject by Mr. K. L. Kaschka, which will doubtless be of interest to some of our readers. The excellent photographs by Herr Koch, at first led the author to believe that they could be made without great difficulty, but an unexpected difficulty was soon met with, namely, it was impossible to find a coloring matter which would so act upon the sensitive plate as to make the bacteria print sufficiently black. Anilin colors, methyl violet, fuchsin, and brown, were first tried, but only the first two colored the bacteria well, and although deeply colored as viewed by the ocular, they were scarcely to be distinguished on the photographic plate, even when the latter was made very sensitive. Tincture of iodine

and solutions of gold and silver salts were also tried with negative results. Finally the cell-wall of the bacteria was subjected to a photo-chemical process in the following manner: After the drop containing the bacteria is dried upon the slide in the usual manner, the spot is moistened with an aqueous solution of a metallic iodide (cadmium iodide 1 : 50 was employed) and in two or three minutes the bacteria are sufficiently iodized. The slide is then carefully and rapidly washed with distilled water, and immediately flowed with a few drops of silver-solution from the negative-bath. If the process has been properly conducted, if the iodide has acted long enough and the subsequent washing has not been continued too long, the contour of the dried spot will be seen to show a yellow color, due to iodide of silver which is formed. A momentary exposure to light is sufficient, after which the developer (strongly acidified and dilute iron-developer) is added, and the drop suddenly becomes black. After thorough washing, the deeply colored bacteria are mounted in balsam and they may then be readily photographed. Even the *Bacterium termo* is thus readily pictured.

This method is only useful for photographic purposes, and there is some chance of mistaking fine silver precipitates for micrococcus or other forms. In case of any doubt of this kind, the original forms should be stained with anilin colors and examined in the usual way.

EDITORIAL.

—This number of the JOURNAL will be sent to many who are not subscribers, in the hope of inducing them to send in their names, and one dollar for the current volume.

Every new subscriber contributes just so much, not only to the support of the JOURNAL, but also toward its excellence and value, by enabling the publisher to spend more money for the illustration of valuable articles We solicit the support of every man who is a member of a microscopical society. If we could obtain this, we would ask for nothing more.

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PHYSICS OF THE MICROSCOPE.—So many correspondents have expressed a desire to have us publish some articles upon this subject, that we have finally concluded to print the greater part of an article which we read about a year ago before the N. Y. Academy of Sciences. It has been our intention to write some articles for the JOURNAL upon this subject, but upon looking over the one already written it seems to cover the ground very well.

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CATALOGUE OF DIATOMACEÆ.—We are pleased to announce that the publication of this valuable catalogue of Mr. F. Habirshaw, is now assured. The subscriptions are barely sufficient to pay for the cost of the printing, but the work was not undertaken in the expectation that it would prove remunerative. The manuscript will soon be in the printer's hands, and the first part will probably be ready for distribution in the course of two months.

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HANDBOOK OF ADULTERATIONS.—In consequence of the demands upon our time, which the immediate publication of Mr. Habirshaw's "Catalogue" as well as other work of a different nature necessitates, we have decided to withdraw the "Handbook of Adulterations" for the present. Numerous contributions have lately been made to the subject of adulteration, and the delay will enable us to make the work still more valuable.

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FRESH-WATER RHIZOPODS.—The valuable work by Prof. Joseph Leidy, on the "Fresh-water Rhizopods of North America," has received well-

deserved praise from all who have seen it. However, it is a work which must necessarily be limited in its distribution. For this reason, the Editor of this JOURNAL has prepared a small book, based upon Prof. Leidy's work, which gives a full and clear description of every species described by Prof. Leidy. Besides the description of the species, synoptical tables have been prepared, which render it possible for even the beginner to determine the genus, and often the species, of any form that may be found, by a hasty examination of its principal characters. This feature of the book makes it a valuble adjunct to the larger one, for it serves as a key to the latter. It is believed that the descriptions of species, which are in great part copied from the originals, will enable any person to determine the name of any Rhizopod described in the book. The index is arranged to be used as a check-list.

It is hoped that the publication of this inexpensive book, will give an impetus to the study of the fresh-water Rhizopods, which are truly beautiful objects and very abundant. They are, perhaps, seldom seen by the ordinary observer, simply because they are overlooked, but if attention is once directed to them, they will be frequently found. Since Prof. Leidy's book was published, we have learned this by experience. Only a few days ago, for example, we found three distinct species of the shell-covered forms in a single dip from a small aquarium, viz.: *Difflugia globulosa*, *D. corona*, and another broken shell which we did not name, besides, a beautiful *Amœba radiosa*; and last month we referred to *Clathrulina* from the same source.

The book referred to above, will contain 64 pages and will be ready about March 30th. Price, in cloth, 75 cents.

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THE BACTERIA.—Dr. George M. Sternberg, who is well known to the readers of this JOURNAL for his work as a member of the yellow fever commission of the National Board of Health, at New Orleans, has translated the excellent work of Dr Antoine Magnin, *The Bacteria*, and the translation has been published by Messrs. Little, Brown and Company, of Boston. It forms a book of 227 pages, illustrated by a number of heliotype and lithograph plates. "To the naturalist, it cannot fail to be of value, as the most approved classification, that of Cohn, is given, with a full description of species. To give additional value to this portion of the work, figures of many of the best known forms, drawn from various foreign sources, and reproductions of some of my own photo-micrographs have been introduced."

The work is divided into two parts, treating respectively of the morphology of the Bacteria, including their organization, classification, and the description of their genera and species; and of the physiology of the organisms.

We have read the book carefully and with much interest, and we regard it as a very valuable one for the microscopist to possess.

In this connection we may remark that the relations of Bacteria to diseases are still uncertain, and a wide field for investigation is still open for the medical practitioner who will devote a portion of his time to the subject. No sooner are they apparently shown to be the active agents in a disease, than another investigator refutes the conclusion by contradictory experiments. The *Bacillus anthrax* does not seem to be necessarily present in anthrax, relapsing fever is not always accompanied by a specific bacterium,and Listerism has lost many of its followers, who have concluded that the carbolic spray does more harm than good. Dr. Sternberg's book will prove a most useful guide to any person who desires to study Bacteria.

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How to See with the Microscope.—The long-expected book of Prof. J. Edwards Smith, with the above title, has at last been published by Messrs. Duncan Brothers, of Chicago. It is difficult to form an estimate of the value of the book to the general microscopist. As an exposition of the author's opinions as to the intrinsic value of various objectives and the usefulness of wide angular apertures it posesses some interest, for his opinions are based upon the results of practical experience in testing them; but opinions of this kind are often misleading, unless they are guided by a regard for underlying principles, and so far as we are able to judge, Prof. Smith's conclusions are purely empirical.

While we do not doubt that the student would find many useful hints regarding the manipulation of the microscope for the resolution of the most difficult test-objects, and some very practical and excellent hints about stands, and the examination of objectives, we are forced to conclude that further than this the book posesses but little value.

The discussion of angular aperture is very diffuse, and it is clear that the author is not familiar with the subject in its theoretical relations. No reference is made to numerical aperture, but on page 118 we read that "'angular aperture' *per se* is not a fixed and definite quantity nor one that can be fenced in and subjected to any fixed rules. Nothing definite in the way of rigid law can be applied to it," which is a remarkable assertion to make at this late day. However, it appears that the author has totally ignored any correct methods of measuring angular aperture, but still abides by the old-time custom (p.96).

Balsam-angle is touched upon, very lightly however, and a brief allusion is made to oil-immersion objectives, but the learner must seek elsewhere for any useful information upon these subjects.

The illustrations on page 244 are very misleading if they are intended to represent, even diagrammatically, the manner in which oblique light is supposed to reveal striæ; but perhaps we do not fully understand their significance.

From a scientific point of view, the book is already far behind the times.

The "Supplement" contains a list of Prof. Smith's contributions to the subject of objectives, and reprints of a series of letters which were written by him in the course of a controversy between the author and the Editor of this Journal. It is to be hoped that these letters will be highly edifying to the readers of the book, but in case any of them should have occasion to refer to the replies to those letters, which are not published in connection with them, we deem it proper to remind them that they were written four or five years ago, and although we believe that our opinions have not since undergone any very radical changes, we were not then familiar with the labors of Prof. Abbe and others, and perhaps now we would express them in somewhat different form. However, we may feel consoled by the reflection that our name has been inscribed upon the pages of a book that will doubtless find many readers, and that it will thus become known to coming generations, even though not under circumstances most favorable for appreciation and fame.

The book contains over 400 pages, with illustrations of stands and some accessories. It is printed on good paper, but the typographical work is inferior and the binding is poorly done.

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Sprouting Milk Globules.—A long article, by Henry A. Mott, Jr., Ph. D., etc., has lately been published in *The American Dairyman*, which would afford an excellent text for a discourse about false interpretations of common facts. An illustration, copied from M. Turpin, accompanies the article, and its purport is to show

that milk globules, can be seen to germinate and to produce long filaments which resemble the mycelium of *Pennicillium*. When we consider the nature of milk globules, which consist essentially of fatty matter, perhaps with a membranous investment, the utter absurdity of the entire article will be patent. The principal authority referred to by Dr. Mott, is M. Turpin, whose contribution was published in the year 1837. As an indication of the nature of his experiments, we quote from Dr. Mott's article as follows: "If, he says, as I have done many times, globules of cow's milk are spread out between two plates of thin glass, * * * these globules will soon be seen to germinfite and produce the *Pennicillium glaucum* up to its last stage of fructification." This simple process is presumed to preclude any contamination with fungus spores! If Dr. Mott does not know that his article conveys false information to the readers of the *Dairyman*, then the fact should be made known to him. The conclusions are no more firmly established than are those which he has announced as the results of his own observations upon the fungoid origin of diphtheria, the microscopic characters of oleomargarine, or the poisonous action of bread made with alum baking powders.

CORRESPONDENCE.

TO THE EDITOR:—The January number of the JOURNAL is at hand, and as the second paragraph of the article entitled "A New Objective," evidently refers to a statement of mine made some time ago, I ask permission to offer a few words of explanation. I think the old doctor gave his student excellent advice when he told him *first* to diagnose his case—then give his medicine.

I have never tried to convince anyone that there is any practical use in an amplification of 30,000 diameters, but I have used this power in testing objectives and also for certain micrometric manipulations. But I do not and have not claimed, in any instance, that I ever saw a structure with 30,000 which I could not see with 1,000 diameters. But I do claim, and think I have fairly demonstrated, that as high a power may be obtained by a $\frac{1}{8}$ or $\frac{1}{10}$ objective as with a $\frac{1}{25}$ or $\frac{1}{50}$. In the first case a higher eye-piece is needed while a comfortable working-distance is kept, but in the second case the working-distance is encroached upon to such an extent as to make it very annoying. If the camera-lucida is used it is necessary to use the lower eye-pieces; even the $\frac{1}{4}$ inch eye-piece will present difficulties, but in all other cases it seems more convenient to have greater working-distance.

In deciding which of two objectives is the better one, it quite frequently happens that there is no perceptible difference under low eye-pieces, and if the question is decided at all, it must be done under high eye-pieces, when, if there is any difference, it is shown. But this has nothing to do with general observations, for which there is no use for higher powers than those which show the object best.

ALLEN Y. MOORE.

——o——

TO THE EDITOR:—The communication of Dr. Detmers (page 37), and your remarks on the same, have been read with interest. Before accepting Dr. Detmers' observations with the homogeneous immersion $\frac{1}{18}$, would it not be well to understand what he refers to, when he speaks of seeing the flagella of *Bacterium termo?* In his last report he refers to an organism under this name, which most people would class with the bacilli.* When Dr. Dallinger speaks of this organism, we know that he refers to the genuine elliptical schizophyte; but, even then, were it not for this high authority, we should have doubts as to the certainty of the glimpse of this organ, seen *after five hours' incessant watching*. We should hardly believe our own eyes under such circumstances. The flagella, of certain bacilli, are much more easily seen.

Your readers may remember that it was only two years ago that Dr. Detmers described the schizophyte of swine plague as a bacillus with globular spores. He was certain of this, because he had watched the globular bodies germinate and form bacilli.† This was with a Hart-

* Report Department of Agriculture, 1879, Fig. 8 of Chart, object 1; also, text, last three lines of page 414.

† Report Department of Agriculture, 1878, p. 362.

nack objective. He then used a Tolles $\frac{1}{10}$, and discovered that the so-called germs or spores multiplied by fission and formed zoöglœa clusters; but they were still spores, and developed into rods.* Finally, he has obtained a $\frac{1}{18}$ homogeneous immersion; and, presto! the *Bacillus suis*, christened by him so short a time ago, becomes a bispherical schizophyte flourishing a flagellum. Are we to understand that the bacillus theory is completely overturned by the new lens? Certainly a bispherical organism, multiplying by fission, forming zoöglœa clusters, and furnished with a flagellum, is a curiosity among bacillus spores. What a wonderful effect an objective may have on the natural history of a schizophyte!

Possibly the new objective will enable Dr. Detmers, in his next report, to give some tangible evidence for the assertion, that the bispherical organism "*constitutes the cause of swine plague*."

A SUBSCRIBER.

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TO THE EDITOR.—I am authorized by the President of the American Society of Microscopists, to announce to the members, and to all others who may be interested, that the Executive Committee have decided, by an almost unanimous vote, to accept the invitation received from the Tyndall Association of Natural Science, of Columbus, Ohio, and to call the next meeting of the Society at that place on Tuesday, Aug. 9th, 1881 (the week previous to the meeting of the American Association for the Advancement of Science, at Cincinnati).

Permit me to add a word upon another matter. The *Proceedings* of the American Society. which should have appeared two months ago, have been unavoidably delayed by circumstances which I shall explain to members at the time of issuing the volume. The latter is now in the press and will be sent before the end of the month.

ALBERT H. TUTTLE, Sec'y.
COLUMBUS, OHIO, March 1st, 1881.

——o——

TO THE EDITOR.—Your kind criticism of my communication upon objectives, which appeared in your February number, I have read with some care, and (pardon me), I fail to see the point. In that communication I was not writing with critical accuracy, nor was I writing upon the question of, "How we see," or that of penetration. The remarks upon these questions were incidental, merely. As to the matter of definition and form being the effect of light and shade (not shadow), so to speak, I would remark that whether the rays from the mirror be oblique or direct, still, if not direct, then by refraction and reflection, they reach the optic nerve, or no sensation of form is produced. And if beyond the eye-piece a photographic arrangement be placed, we get the form fixed in light and shade, and call it a photograph. But I cannot herein amplify upon this question; with your permission I will hereafter give my ideas upon this subject, making it, I hope, simple enough to be understood by average people.

Respectfully,
S. A. WEBB.
OSWEGO, N. Y., March 1881.

* Report Department of Agriculture, 1879, p. 413. Dr. Detmers' report is here dated February 28th, 1880.

NOTES.

— A new edition of Rabenhorst's *Kryptogamen-flora* is in course of publication. The several departments of cryptogamic botany will be edited by gentlemen of acknowledged ability. Each volume will contain, besides the systematic part, an account of the structure, life and development of the forms described, and, with the exception of the marine algæ, each genus will be figured.

—Mr. L. R. Sexton announces a new fine-adjustment for Gundlach's microscopes, consisting of "a combination of two screws which give a resultant motion equal to the difference in the threads employed," so that the adjustment is more delicate than it is possible to have with the ordinary screw, without a sacrifice of its durability. The two screws can be made to work independently, thus giving a more rapid motion than the ordinary adjustment, which is very convenient for low powers, or they may act together, and then the movement is much more delicate

—We regret to hear that *Index Medicus* is likely to suspend publication from want of support. It is unquestionably one of the most valuable publications that the medical profession could have, and yet while hundreds of utterly worthless medical journals flourish, this, which has an intrinsic value not easily over-estimated, seems likely to be allowed to pass out of

existence. We thought, at first, that it was too valuable to be appreciated.

—Teeth of *Sargodon tomicus*. Mr. Charles Stodder is selling some very interesting sections of fossil teeth from the bone-breccia of the Penarth beds of Wales. The teeth from this stratum occur in various forms, but it has finally been decided that they all belong to one species. Those that are wedge-shaped seem to have been used for cropping algæ, while the others covered the interior of the mouth, like a pavement, and were employed in crushing the food. The microscope has revealed their true nature, and their structure is very beautiful. They should be examined both with and without polarized light.

—In the *Zeitschrift für Mikroskopie*, Prof. Leopold Dipple has a long article entitled, "Remarks upon some Species of Diatoms used as Test-objects," which is illustrated by four lithograph plates. It includes *Navicula rhomboides*, Ehr., and its variations, some forms of *Grammatophora*, and the *Nitzchia curvula* of Möller's test-plate.

—One of the oldest, and certainly the most reliable and valuable, of the scientific periodicals in the country is the *American Journal of Science*, published at New Haven. by Professors J. D. & E. S. Dana. It was founded by Prof. B. Silliman, in the year 1818, and closed its 120th volume in 1880; the full set, therefore, contains in its articles, reviews and notices, a good record of the results of American scientific labor during the sixty years of its existence. The subscription price is $6.00 per year.

—We have received from Mr. J. L. De La Cour, of Camden, an excellent photograph of a portion of a frustule of *P. angulatum*, taken by Mr. H. S. Fortiner of that place, from one of Dr. Woodward's photographs. The photograph is a positive on glass, which was made to use with a projecting lantern, for the purpose of illustrating lectures. Mr. Fortiner has prepared a series of these slides, but whether they can be purchased or not we cannot say. They will certainly prove very useful.

—Dr. J. W. Edwards, of Mendota, Ill., reports six cases of trichiniasis, caused by eating pork that was not thoroughly cooked, four of which have terminated fatally.

—Messrs. J. W. Queen & Co., of Philadelphia, have recently issued a "Supplementary Catalogue" of microscopical apparatus which they have on hand. The prices of which have been marked down, so as to make quick sales. We notice a Beck "Large Best Binocular" reduced from $250 to $190 and another with accessories, reduced from $335 to $230. A number of objectives of the late firm of C. A. Spencer & Sons, Gundlach, Tolles and Queen, are offered at reduced prices, and a list of objectives by Beck (1876), are offered at prices about fifty per cent. lower than those charged by the maker. There are some excellent bargains offered in this Catalogue.

MICROSCOPICAL SOCIETIES.

ELMIRA.

The regular meeting was held on January 27th. Dr. S. O. Gleason, the President, in the Chair.

Letters were read from the officers of the American Society of Microscopists, relative to holding the next National in Elmira.

Judge Davis then read his paper upon the Hypothesis of Evolution.

He disclaimed giving any ideas of his own, simply relating in his own language, and in a condensed form, that which he has read upon evolution. Twenty years ago, Darwin published his work on the origin of species. Prior to that time, the greater number of naturalists had believed that species were immutable, and always continued the same, being separate creations. The intention of Darwin's book was to set forth a "theory," upon which the chasms between species could be bridged. Darwin formulated his hypothesis of the mutability of species under four fundamental first truths:

1st. Variability; 2d. Atavism; 3d. Struggle for Existence; 4th. Survival of the Fittest.

The first two inhere in all organic growth and reproduction. The third relates to the conditions of this organic growth, and the fourth to the inevitable results which follow from the operations of the first three. These were clearly expounded, and a large number of interesting facts and illustrations of the tendency of nature to vary the species, were given. The causes that led to variations were fully explained and entertainingly com-

mented upon. How the variations in animals and in plants that are desirable, are perpetuated, was explained, and numerous examples given.

Huxley was the first to apply the evolution hypothesis to man, in his three essays, *History of Man-like Apes, Relation of Man to the Lower Animals, On Some Fossil Remains.* These essays were given in brief. Darwin's *Descent of Man,* in which he carries out his theory of the evolution of man, was referred to. Neither Darwin nor Huxley have formulated a theory accounting for the beginning of life. But Häckel carries his theory of evolution back to the origin of life, upon a purely materialistic basis, commencing with a spontaneous generation of the *monera,* tracing the development from the structureless protoplasmic mass, through twenty divisions of ancestral stages, to man.

The entire lecture was closely listened to, and gave great delight to the intelligent audience assembled.

The paper was discussed by Prof. Ford, Dr. Krackowizer, J. H. Barney, the President, and others.

THAD. S. UP. DE GRAFF,
Secretary.

LIVERPOOL (ENG.)

The Annual Meeting of the Liverpool Microscopical Society was held at the Royal Institution, Colquitt Street, Dr. Hicks, the retiring President, in the Chair.

On the nomination of the committee, Dr. Hicks and Mr. W. H. Weightman, were elected Vice-Presidents, Mr. W. J. Baker and Mr. I. C. Thompson, F. R. M. S., were reappointed Honorary Treasurer and Honorary Secretary, respectively.

Dr. Carter, the President-elect, then delivered his inaugural address. In some preliminary remarks he criticised unfavorably the presumed universal diffusion of a single substance of uniform composition, which serves as the physical basis of life. What, at most, could be meant, unless evidence was to be disregarded, was "protoplasms" (plural)—*i. e.*, the substance special to each kind of organism, on the presence of which, its vital manifestations might depend, and not a single protoplasm of undeviating composition, which lay at the root of all vital manifestations whatever. He drew attention then to the influence exerted by a number of agents on vegetable cell-development, and more especially of light and darkness, pointing out simple apparatus by which the action of rays of light of different refrangibilities could be studied; of oxygen, carbonic acid, iodine and ether. He gave illustrations, in growing seedlings, of the retarding effect exercised on vegetable cell-development of even very minute quantities of alcohol, one part in 400 often preventing development altogether, while a markedly retarding effect was produced by even one part in 3,200. He also drew attention to the strong inherent vitality of the vegetable embryo of even the more highly organized plants, by the power which it possessed, of surviving even severe mutilation, illustrating the fact by a number of actively-growing seedlings, reared from seeds which had been cut into various pieces, and otherwise injured. A very interesting fact, which seemed to have been established, was that light, either alone or in conjunction with moderate warmth, was not sufficient to develop chlorophyll in etiolated plants. Specimens of seedlings in illustration of this proposition, which is contrary to the generally conceived opinion, were exhibited.

The thanks of the meeting were accorded to Dr. Carter, for his address, and the usual conversazione followed.

ONEIDA CO., N. Y.

Friday evening, January 25th, sixteen gentlemen of this city and vicinity, who are interested in microscopy, met and formed an organization, to be known as the "Oneida Co. Microscopical Society." The constitution and by-laws adopted are essentially those of the American Microscopical Association. The following officers were elected for the coming year: President, Prof. A. H. Chester; Vice-President, Dr. Theo. Deecke; Secretary, Geo. C. Hodges; Treasurer, H. P. Mallory; Memb. Ex. Comm., Thos. Burt.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Several dozen slides, French and English, general natural history subjects, exchanged for good rock or mineral sections—list furnished.

WM. M. COURTIS, M. E.,
Wyandotte, Mich.

Well-mounted diatoms, in exchange for other good slides, material, etc., etc. W. H. TIVY,
Sixth and Olive Sts, St. Louis, Mo.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

VOL. II. NEW YORK, APRIL, 1881. No. 4.

Charbon and the Germ Theory of Disease.

BY D. E. SALMON, D. V. M.

I.

The study of contagious diseases is to-day the most important work attracting the attention of scientific men; for not only is the loss of human life from them enormous, but the loss of property by their ravages among our live-stock, and the necessary obstructions to commerce is becoming a matter for the most serious consideration.

Until the last few years the contagious plagues of men and animals have been shrouded with the most impenetrable mystery, to be explained only as punishments sent or allowed by an angry God; and when the black plague destroyed twenty-five millions of people in Europe at a single invasion, or when it devastated such great cities as London, there were few, if any, who imagined it possible for medical science to combat these terrible scourges with any hope of success. But quarantines have already done much, and it is only in exceptional instances that the advance of exotic pests, like cholera, yellow fever or the plague, causes any serious alarm.

Notwithstanding this, however, we have among us a number of contagious diseases, from which the country is never entirely free, which cause far greater losses of human and animal life than the majority of people ever imagine. There is small pox, now robbed of many of its terrors by a general system of vaccination; scarlatina, which is often responsible for ten per cent. of the annual deaths in entire States; diphtheria, which causes an equal mortality; typhoid and puerperal fevers, measles, whooping-cough, syphilis, pyæmia and septicæmia, all of which help to swell the mortality lists. Then as affecting animals, and communicable from them to man, there are such horrible and fatal maladies as charbon, rabies, glanders, and, overshadowing all other plagues in importance, tuberculosis. Finally, as affecting and causing immense losses among animals, we have pleuro-pneumonia (bovine), rinderpest, Texan fever, swine-plague and fowl-cholera. Not less than one-seventh of our people die from tuberculosis alone, or, in the United States, one hundred and twenty-five thousand annually; and if we add the losses from other zymotic diseases we will double this number, and have in all a mortality approaching that caused by our late civil war.

With this introduction to indicate the importance of the most thorough knowledge of these diseases, I shall enter upon a discussion of the germ theory as applied to charbon, in the hope of keeping my readers interested by the magnitude of the subject, even if I fail to present my views in an attractive style.

Before 1876, we were totally without satisfactory evidence in regard to the nature of the virus of any zymotic disease, but Koch's investigation of charbon, published in that year, made it so clear that this malady was due to a bacterium, called the *Bacil-*

lus anthracis, that the germ or bacteria theory of contagion received a new impetus, which has done much for the elucidation of the whole question. There have always been doubters, however, particularly among English-speaking people, most of whom have been unable to follow the investigations as closely as is necessary to reach sound conclusions; and now, when Greenfield has shown that the twelfth cultivation of the *Bacillus anthracis* no longer produces disease, though its morphological characteristics remain the same, there is a renewed tendency to doubt the connection of this organism with the contagium. It is not uncommon to see such doubts expressed in very strong terms in medical and scientific periodicals, and, if I am not mistaken, a similar tendency has been shown even in the editorials of this JOURNAL. Only a few days ago I heard a prominent medical man, in one of our large cities, offer a challenge to the believers in the germ theory, to discuss the reasons for their views in regard to any disease. It seems opportune, therefore, to present the evidences for the faith that is within us, so that all may see that we have a foundation clearly and firmly established. With this view I take up the disease known as charbon (anthrax, malignant pustule), because it has been more thoroughly investigated than any other contagious disease.

Since about the year 1850, the presence of rod-like bodies, such as I have figured at *a*, has been admitted to exist in the blood of the great majority of cases of charbon. By some they were regarded as crystals, but by others they were described as a form of bacterium, called by Davaine, *Bacteridia*, and by Cohn, *Bacillus anthracis*. Koch was the first to show that after the death of the animal, or when removed from the body before death, if surrounded by certain conditions of temperature, etc., these rods increased in length, and there were formed within them bright, refringent granules, as at *b*. These granules were afterwards liberated by the disintegration of the filaments, and then existed in an isolated condition as at *c*. Finally, the isolated granules, when placed in a fresh cultivation-liquid—like the aqueous humor—sprouted and formed rods such as were originally present in the blood of the sick animal; the rods would again form filaments, and the filaments then break down into granules

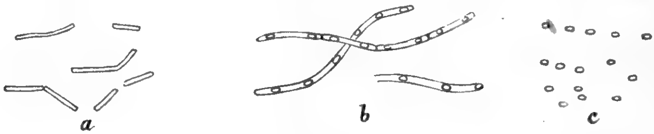

FIG. 16.

as before. The granules were, consequently, resting-spores, while the rods were the actively vegetating condition of the organism; the former were comparatively dormant and might be likened to a grain of corn, which, as we well know, retains its vitality though exposed to great extremes of temperature, though withdrawn from the influence of the sun and air, and even germinates after passing through the entire digestive tract of a large animal like the ox, or after having been buried in fermenting manure for a considerable time. The rods, on the other hand, show an active form of life, and may be compared to the growing maize plant, which is so easily destroyed by frost or drought, and to the existence of which the sun and air are so necessary. That is to say, a spore or seed retains its vitality, and is capable of growth and reproduction after having been exposed to conditions which would assuredly destroy the life of the growing plant or fungus. I ask the closest attention to this point, because it is

from this fact that I hope to convince my readers of the connection between the *Bacillus anthracis* and the contagium of charbon. It is the line of argument originally used by Koch, and to me it seems to be a perfect demonstration.

By the cultivation of this organism on growing slides, it was found that it could not form spores unless the atmospheric air was freely admitted; it also required for this purpose a temperature above 12° (53.6° F.). If the conditions of temperature, ventillation and concentration of nourishment were such that spores could not be formed, the rods perished in a few days. Now, it is a most interesting question to know if the activity of anthrax virus disappears with the death of the rods when spores are not formed, and if it is preserved indefinitely after the formation of such spores; and this question is doubly interesting because the conditions which affect the death of the rods before spore-formation are such as will preserve unstable chemical compounds. For instance, such a chemical substance is best preserved by cold and protection from atmospheric oxygen, as well as by drying; but these conditions prevent the formation of bacillus spores, and, hence, lead to the death of the organism in a very short time.

If, therefore, the activity of fresh charbon blood (which only contains rods) is lost in a few days when exposed to a low temperature, if it is similarly lost when hermetically sealed in glass tubes, or quickly dried, especially if the loss of the activity corresponds with the death of the rods as determined by microscopical observation and cultivation-experiments, we have good evidence that this activity is due to the *Bacillus*. If we can go even beyond this and prove that, when the spores are once formed, the activity of the virus is retained indefinitely though exposed to cold, drying, putrefaction, or when hermetically sealed, then, I maintain, we have a demonstration that the *Bacillus anthracis* is the essential cause of charbon, and that the disease is due to no other agency.

The following observations are presented as deciding the question:

1. Blood and pieces of spleen, or lymphatic glands, if dried as soon as possible, after the death of the animal, soon lose their activity—the smaller particles in twelve to thirty hours, and all within five weeks. When their inactivity is proved by inoculation, cultivation-experiments show that the *Bacillus* has perished.

2. Such pieces of spleen, or glands, which have been dried slowly in a warm room, may retain their virulence for certainly four years. These are found to contain spores which may be cultivated and which grow into filaments that again form spores.

3. If a bottle or test-tube is filled with charbon blood, tightly corked, and placed in an incubator at 35°, it very soon has an extremely disagreeable odor of putrefaction, and within twenty-four hours the rods have disappeared, and the fluid is no longer capable of producing the disease when inoculated. This is evidently due to the absorption of the available oxygen by the septic bacteria, as may be rendered clear by the next two paragraphs.

4. If a drop of such charbon blood is placed on a slide and covered, and the cover cemented air-tight, the rods grow until the oxygen is exhausted, as shown by the spectroscope, they then remain stationary, and in a few days become granular and disintegrate without forming spores. Such blood is no longer capable of producing charbon.

5. If the charbon blood be placed in a watch-glass where there is free access of air, and then kept in an incubator at a proper temperature, the putrefaction goes on as before, and swarms of micrococci and bacteria appear. The development of the *Bacillus anthracis* is accomplished, however, as though no other

organisms were present, the spores are formed and sink to the bottom, and inoculations produce the disease for a long time afterward (at least twelve weeks, as shown by experiment).

6. When substances containing the *Bacillus* rods alone are somewhat diluted with distilled or well-water, the development of the rods is not stopped; but if the dilution is excessive, the organism is soon destroyed, and after thirty hours, inoculations fail to produce the disease. That is, the actively growing organism requires a certain concentration of the nutritive fluid in order to accomplish the spore-formation.

7. If flakes containing spores are taken from a watch-glass (paragraph 5 above), containing putrid but still virulent blood, and placed in a test-tube full of distilled water, the virulence is not destroyed, but is retained for weeks unchanged.

8. Such flakes may also be dried, and after a certain time moistened with water and again dried, and this repeated indefinitely without destruction of the virulence.

9. A watch-glass of fresh charbon blood placed in a room at 8° (46.4° F.) remains virulent for only three days. The rods at this time have not formed spores and show the granular, disintegrating appearance which indicates their death.

Here, then, we have a series of facts which show the connection between the virulence of the blood and the presence of the living *Bacillus anthracis*. A single fact of this kind might indeed be called a coincidence, but even two such facts would, from the nature of the case, afford a strong probability of the virus being identical with the organism; but when it comes to a set of nine facts, each of which taken alone would be a remarkable confirmation, it seems to me that, as scientific men, we must accept them as a demonstration. If 45° destroys the virus before spores have formed, but has no effect upon it afterwards; if diluting the virus largely with water destroys its power before spores have formed, but has no effect upon it afterwards; if hermetical sealing destroys the virus before spores have formed, but is without effect after such spore-formation; if putrefaction destroys the virus when there is not sufficient access of air for the formation of spores, but has no effect under opposite conditions; if, in short, the preservation of the virus for any considerable time only occurs when the conditions are such that resting-spores form in the *Bacillus* rods, then, I have no hesitation in accepting it as a fixed fact that charbon is caused by the *Bacillus anthracis*, and that the contagium, or virus, consists of this alone.

None of the later investigators, so far as I am aware, have published a single experiment to show that the above facts, observed by Koch,* were in any degree doubtful or unreliable; on the contrary, they have been confirmed in a remarkable manner by Cohn, Pasteur, Toussaint, Greenfield, Buchner and others.

In this article I have purposely avoided any reference to those observations which, it is asserted, conflict with the conclusion that charbon is caused by this bacterium. It is simply my object, at present, to make it clear that the organism and the virus are one and the same thing, and I believe that any unprejudiced scientific man must accept this conclusion as necessarily following from the above facts. At another time I may take up the observations which are believed by some to conflict with this view.

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—An interesting article by Professor J. C. Arthur, on the trichomes of *Echinocystis lobata*, with a plate, is published in the *Botanical Gazette* for March, 1881.

* Dr. Koch, Die Aetiologie der Milzbrand-Krankheit, begründet auf die Entwicklungsgeschichte des Bacillus Anthracis. *Beiträge zur Biologie der Pflanzen*, 2nd Band, 2nd Heft. Breslau, 1876.

Diaphragms.

BY EDWARD PENNOCK.

What is the use of diaphragms beneath the stage? It will, I think, be admitted by all, that it is to properly regulate the illumination of the field of the microscope, and to exclude extraneous and confusing rays which do not proceed from the mirror. The only way in which the diaphragm can affect the illumination of the field is by altering the size of the pencil of rays projected by the mirror.* It is the purpose of this brief note to enquire how this object is best accomplished; whether by small diaphragms in contact with the object-slide, or larger ones at a considerable distance below. The former plan seems to be coming into favor and has been adopted by some of the best English and American makers.

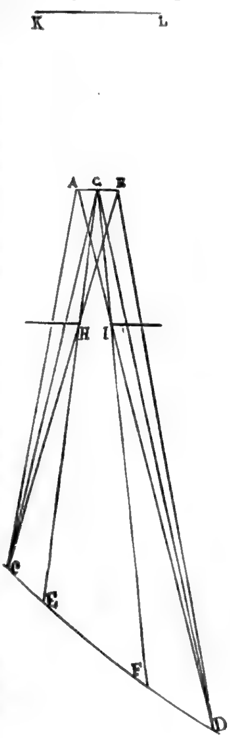

FIG. 17.

Fig. 17 shows the effect of a diaphragm of $4^{mm.}$ aperture, placed at a distance below the slide. The pencil of rays *h g i* of an angular diameter of about 14° is admitted to the center of the field, and a like pencil *h b i* to the margin, illuminating the whole field evenly, supposing of course that the source of light whose image is formed at *a b* is of sufficient size and of uniform intensity, and that all the rays are taken up by the object-glass. The use of a ruler in connection with the diagram will demonstrate the latter point (to avoid confusion the lines are not given in the engraving). With an object-glass of 1 inch focus, 36° aperture, it is evident that the margin of the field will be as brightly illuminated as the centre; with a lens of less aperture the whole of the pencil illuminating the margin of the field, however, will not be taken up.

Suppose we obtain a pencil of rays of the same angle, by means of a small diaphragm placed near the object, we will immediately find that the field of view is very much cut down, while the illumination of the centre of the field is the same as before. In order to have the whole field illuminated, it will be necessary to use a diaphragm-aperture as large as the field of view; in which case the diaphragm exerts no control over the illuminating pencil, and we have a flood of light from the mirror and surrounding luminous sources, destroying definition. A reference to Figures 18 and 19 will make these points clear.*

FIG. 18.

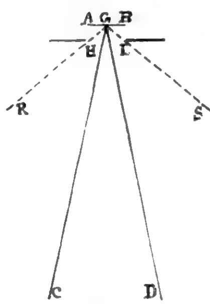

FIG. 19.

* It is assumed that the mirror is placed at the distance of its focal length below the object.

* In order to secure an evenly illuminated field with very low-power objectives of small angular aperture, it may be desirable to focus the mirror upon the objective, thus transmitting light through all parts of the object to the object-glass. In this case, the position of the diaphragm is not of so much importance, as it cannot then regulate the intensity of the illumination to any great extent, even when in its best position, but merely the size of the field.

Now take the case of a high-power, say a ¼-inch. The field of view (*a b* in Fig. 20,) let us suppose, is 1$^{mm.}$ in

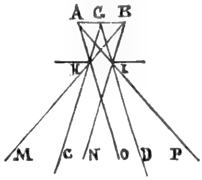

FIG. 20.

diameter; the thickness of slide, or distance of diaphragm below the object, the same; the diaphragm-aperture *h i*, .5$^{mm.}$ (For simplicity's sake, the effect of refraction of the slide is not shown.) A pencil of light of about 30° is then admitted, axially, to that part of the object in the centre of the field; but those which lie near the margin are illuminated only by oblique rays (either from the edge of the mirror or outside luminous objects, or both) as is perfectly evident from the diagram: and suppose we have a valve of *P. angulatum* lying near the margin of the field, it will very likely be resolved by this mode of obtaining strictly central illumination. If a larger aperture is used, extraneous rays will be admitted, and the definition correspondingly marred. But

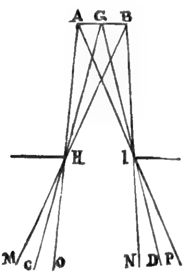

FIG. 21.

suppose we obtain an illuminating pencil of rays of the same angle as before (30°) by placing a larger diaphragm at *h i* in Fig. 21; approximately central light is obtained for all parts of the field, and outside rays are excluded from the object and object-glass.

Diaphragms the size of the field, placed immediately above or immediately below the slide, may be of use to exclude rays from the marginal portion of an object-glass that cannot be brought to a focus within the field, and which consequently do no good but rather harm by causing reflections from the various lens-surfaces of the object-glass. In this case, such diaphragms would, no doubt, be beneficial; but they would have this function only, except in the case of the highest powers, and would not obviate the necessity for others placed at a suitable distance below. The

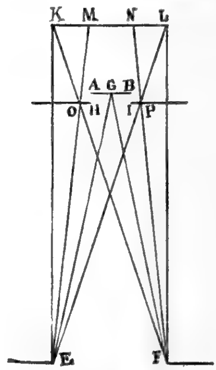

FIG. 22.

diagram (Fig. 22) shows the diaphragm *h i* in place just beneath the object; the rays *e k*, *e m*, *e l*, *f k*, *f n*, *f l*, which could not form any image in the eye-piece, are prevented from entering the object-glass.

It therefore appears that each sort of diaphragm has its own particular function or functions; of which those possessed by the diaphragms at a distance below the object are the more important. But the perfect microscope must have both.

PHILADELPHIA, Feb. 25th, 1881.

Motion of Diatoms.

BY J. D. COX.

The investigation of the motion of diatoms is occupying the attention of observers in Europe, and a Russian naturalist has recently published some experiments made with infu-

sions of coloring matter which were conducted in a similar way to those made some years ago by Prof. H. L. Smith with indigo.* Prof. Smith noticed that particles of indigo in suspension in the water were moved along the raphe of the living diatom, sometimes collecting in a ball at the central nodule, and, again, running along to the end of the frustule, were broken and scattered in a rather symmetrical cloud about the extremity of the shell. The later observer has not noted the formation of a ball, or the motion along the raphe, but has reported the cloud-like aggregation of particles, and drawn from the phenomena he witnessed, the conclusion that the cause of motion of the diatom is the exosmose and endosmose of fluid.

Before any satisfactory solution of the problem can be reached, or any decisive determination whether the motion be due to osmotic or to ciliary action, a good deal of patient observation must be made,—both of the motion itself under varying circumstances, and of the structure of the diatom, including the nature of the raphe itself and the question of the existence of a gelatinous envelope covering free as well as stipitate frustules.

The following observations, which have recently been repeated and fully verified, are copied from notes made in the Summer of 1879, and are a contribution to the record of facts which any sound theory on the subject must account for. They certainly seem most consistent with a supposition of ciliary action, though it is possible that some form of osmotic action might produce similar phenomena.

A fresh gathering of diatoms from a little brook near Cincinnati, contained a number of *Nitzschia linearis*, which had progressed so far in self-division that the front view of the frustule was twice as broad as the side view, but from the peculiar form of the *Nitzschia* the carina was in plain view on each edge of the frustule as it lay or moved on its broader side. The first case I noticed was that of a frustule apparently held fast by the glasses of the compressor, but a gelatinous mass of decomposed vegetable matter was seen moving steadily along the frustules from one end to the other, making a momentary halt in the middle. The mass was as large in diameter as the width of the diatom, so that it reached from side to side of the frustule, overlapping the carina of the valve on one side. The motion of the loose matter was once or twice reversed, as if the diatom was trying to back out of its position, and so produced a current in the opposite direction. Presently the diatom got loose, backed out and moved a considerable distance across the field, the gelatinous substance still adhering and being dragged after it. Again an obstruction was met, the diatom stopped, and as if the machine were reversed in the new effort to back out, the foreign matter was again dragged to the foremost end, and this time a smaller floating particle of similar kind moved in the same manner along the opposite valve of the frustule. In an effort to make the diatom roll over, so as to enable me to make more sure of its species, it was swept out of sight and lost.

A little later some fresh samples of similar material afforded a repetition of the phenomena and confirmation of the facts. A frustule of the same species as the former was so wedged in the compressor that one end was free, whilst the other was fast. The free end would move vigorously one way or the other, in an arc of a circle, but the diatom was not released. Attached to it were two gelatinous masses, one on each side, and of similar size to those described in the former case. These were distinctly applied to the valves so that, as the diatom lay in front view, as before, the two masses were on the

* This JOURNAL, Vol. I, p. 182.

opposite sides of the frustule. These masses moved along the sides, sometimes the whole length of the diatom, sometimes only to the middle where they would rest a while, and then either complete the motion or go back. They did not always move simultaneously, nor with the same speed, but with a general agreement of motion. This action was continued half an hour, the diatom not getting free.

Turning to another part of the slide, I found another free moving specimen with a similar gelatinous mass in contact with it. The diatom was moving freely and towing the matter along with it, attached to its hinder end. Soon the mass began to move forward on the shell, the motion of the diatom ceased and was presently reversed, the order of sequence being distinctly as stated. In several instances the motion of the gelatinous mass from the rear end of the diatom forward, plainly preceded the change in the direction of the frustule, as if the change of ciliary motion (assuming that to be the motive power, for the sake of illustration,) did not instantly stop the headway of the diatom, but required an appreciable moment of time to overcome the momentum. My observation of this shell continued for a full hour, the changes of direction being frequent, and all the accidental modifications and phases of the phenomena were strikingly confirmatory of the existence of some force applied along the line of the raphe, acting sometimes in one direction and sometimes in another, in such a way as would be fully explained by supposing ciliary action along that line, but which do not seem to be so easily accounted for by osmotic action, certainly not by osmotic action at the ends of the frustule.

On one or two occasions the acting force did not appear to be reversed at the same instant at the two ends of the diatom. Twice the foreign matter moved against the current of general motion, slowly, it is true, but really in such a way as to indicate that the force acting upon it was not in the same line of direction as was that exerted on the other half of the frustule. But when the motion controlling the gelatinous mass became vigorous, it either became dominant or was indicative of harmonious action at both ends of the shell, so that the motion of the diatom through the water became very pronounced and strong.

I looked for similar phenomena among the other kinds of diatoms in the gathering, but saw nothing of the sort except in the instances described. The Naviculæ were very lively, but I saw no examples of action upon foreign matter that came in their way. Neither could I detect any current, even along the Nitzschias; the motion of the gelatinous substance occurring only when it came in contact with the shell and apparently sticking to it.

My study of the diatom-shell has led me to accept the opinion that the raphe is a real fissure in the shell, but in many species it is not a simple and vertical linear-opening of the shell. It is more like the joint formed by the overlapping of the edges of curved tiling on a roof: a thickened line of silica borders one lateral half of the shell, while the other half dips under it with a thin film. It is true that an osmotic force may be conceived as working along the raphe, as well as that a line of cilia should do so; but the difficulty is to account for such action upon an extraneous mass as that which I have described, or to make osmosis from such a place upon the shell move the diatom in the direction of its length. The assumed presence or absence of a gelatinous film enveloping the diatom does not materially vary the conditions of the problem in either case. If we assume that the osmotic action is at the extremities of the shell, the observed phenomena, as to the action upon the gelatinous mass when in the middle of the frustule, are unaccounted for.

As to the manner in which the lap-

ping of the halves of the frustule along the raphe is effected, it may be most easily seen in some of the coarser Pleurosigmas. In broken shells of *P. attenuatum* and *P. formosum* I have seen it very plainly demonstrated. Sometimes the thickened line of silex which borders one-half of the frustule, will be found sticking out alone, the thinner part of the shell being broken away from it. Sometimes it will be in its normal position, but the lateral halves of the shell will be separated by pressure so as to show on one side the thick edge, and on the other the fitting gutter caused by the projection of a thin lip. Occasionally also a cross fracture of the shell will be found on a broken fragment, in such position that we get the benefit of a cross-section, and see the whole joint in the form I have described.

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Examination of Blood—Dr. Tanner's Blood.*

Under the microscope, blood appears as a colorless fluid, in which float an indefinite number of circular disks, of a pale yellowish color. They assume very characteristic distortions in spreading and in drying, being drawn in at one point into a slight notch, or prolonged into a small sharp prominence, or drawn out into a distinct balloon shape; they are often changed by mutual pressure in drying, so as to indent each other, and, for this reason, along the edge of a small clot they assume an elongated form, pointing toward the edge of the clot. When dried upon glass, they can be easily cut into fragments by drawing a knife or needle-point through the spot, and the fragments, if not quite dry, will round themselves toward or into the appearance of small but perfect disks. I have seen disks which, in spreading very carefully upon glass, for the purpose of retaining their natural appearance, had been torn apart into sections which became round, and would have been considered independent disks, if a slight change of position had separated them from each other and mixed them with other disks. When treated with various solutions, with heat, electricity, or other disturbing causes, they assume forms that are indented, vacuolized, nucleated, surrounded by knobs which often separate into distinct globules, or are resolved into a net work of fine fibres. There is still some doubt as to the exact relation between these artificially produced appearances and the original structure of the disk. They become shrunken and shriveled in long wasting diseases, and by long abstinence from food. At the close of Dr. Tanner's fast of forty days, during which time it is beyond question that he at least abstained from any ordinary and adequate supply of food, the red corpuscles of his blood were found to be extremely shrunken, jagged and broken in appearance, and supplied with roughly projecting points; and, although the character of his blood began to improve immediately after the resumption of an ordinary diet, it was more than a week before all the disks were found to present a normal appearance. The disks may be soaked out almost unchanged from a small dried clot or stain, and may often be recognized in the thin portions of the clot itself, if it be cleared up by dissolving out the coloring matter, and subsequently staining the pale residue. These disks are characteristic of blood, and are positively recognizable by an experienced and competent person. It would be gross incompetence to mistake, for them, starch or wood-disks, about which doubt has been expressed. The real danger of error is in regard to spores, which have been mistaken for blood disks by persons of ability; but such a mistake ought not to occur again; since the danger of it is well-known.

The coloring matter of the blood

*Condensed abstract of a lecture delivered by Dr. R. H. Ward, before the Troy Scientific Association.

has a strong tendency to solidify in the form of reddish crystals, sometimes even within the disk itself. Different forms have been recognized in the blood of several different kinds of animals, but they cannot yet be considered absolutely distinctive, even of the very limited number of animals where they seem to be different from others.

The disks of nearly all the mammalia, including the human races, are round and without a definite nucleus. They are not perceptibly changed by being preserved in a dry state for several years. Measurements can be made of the same objects by means of an eye-piece micrometer, which shall agree, on the average, within 1-300,000 of an inch or less. I have done this repeatedly, and so have many others. The measurements are most conveniently made, and recorded in micromillimetres carried to one place of decimals. Measured thus, the human disks range, as given by a great number of modern authorities, between about 7.1 and 7.9 micromillimetres, the average being about 7.5. The average of many thousands of measurements that I have made is about 7.4. The various human races are practically alike, including the Negro, the recorded measurements varying about 0.1 or 0.2, with no probability that the difference is constant. The blood of various monkeys is very near that of man, with probably no distinctive difference of size. That of the dog has smaller disks, perhaps averaging 6.9, yet no person of good judgment would claim to distinguish it infallibly from that of man, which averages over 7.4. Not that there is any difficulty in attaining that degree of precision in measurement, or much more if required, or in eliminating accidental errors by averaging from a very large number of measurements; but because the normal size of the disks of the dog is so near that of man that the series may overlap, and there may be some dogs whose disks, if every one were measured, would be equal in size to those of some men. Very different is the case of the pig and ox, whose disks measure about 6.0 or 5.9, the horse at 5.5, and the sheep at 4.8. These figures may be large, but there is no probability that any revision will raise them near to those of man, or that a single sheep, for instance, lives whose disks would measure 7.0 and upwards. It is, therefore, safe to say that under favorable circumstances, including the opportunity to examine a large number of characteristic and well-formed disks, the blood of mutton, and probably of any animal whose disks are not larger than those of the pig, can be distinguished from that of men. This is really all that has been claimed by Dr. J. G. Richardson and others, who have claimed decisive value for this method of discriminations. That dog's blood could be thus distinguished, has never been prominently claimed or generally believed; and that any one kind of blood could be, by such means, absolutely and unqualifiedly identified, as distinguished from all other kinds, is simply absurd and claimed by nobody.

Such measurements should be made with powers of not less than 1,000 diameters; 2,000 or 3,000 being preferable. By the use of amplifiers or high oculars, such powers may be attained by almost any microscope; but there are few instruments that can be worked at such powers to advantage, and the successful use of such powers requires great tact and judgment as well as experience in the manipulator.

The quantity of blood required for this method of analysis is really very small. It has been computed that there are about 5,000,000 of the red disks to one cubic millimetre of blood, say the bulk of a common pin-head, and that the weight of each is about 0.00008 of a milligram, so that you could measure 75 or 80 disks without exceeding the use of 1-10000th of a grain of blood.

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The New "Acme" Lithological Stand.

[Messrs. J. W. Sidle & Co., of Lancaster, Pa., have sent us a description of a new stand for lithological work which they have designed, and which will soon be placed in the market; we print it below.—Ed.]

The "Lithological," like all our stands, has our standard tubing, so that the eye-pieces of one fit all the others. The ordinary rotating-plate is omitted and in its place a permanent rotating-stage, graduated to single degrees and very accurately made, is provided. There will be a polarizer on a swinging-arm, to allow of being turned out of the way when not in use. This will be furnished with a graduated circle, and an index indicating the crossing of the prisms. The mount for polarizer has a thread in its upper end to take a lens-system of extreme angle. An improved centring arrangement for the stage proper will be introduced. A Klein's quartz-plate mounted the same as a binocular prism in the nose of the instrument will be provided. This can be removed, and the opening closed by a shutter. An analyzer will also be placed in the nose, in a sliding box with a stop. This also can be removed and the opening closed by a shutter. An extra analyzer, mounted to slip over the eye-piece, and furnished with a graduated disk and index will be provided. Also a calc-spar plate arranged to rotate between analyzer and eye-lens for stauroscopic measurements.

The stand will be all brass, finely finished and accurately adjusted. Its price will not be over $90.00, probably, $80.00.

The lens-system of extreme angle referred to will be the only accessory to be added, to make the outfit complete.

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How to Procure and Mount Raphides.

As a handsome slide of raphides is always attractive, I give the following process for obtaining and mounting them :—

The hanging plant known as "wandering jew" (*Tradescantia*) contains myriads of these needles. Place a slide upon the turn-table, cut off the vine or stem of the plant transversely (somewhat obliquely), and you will find the juice of the plant forming a half drop on the cut end. Set the table in motion without delay, and place the drop on the cut end upon the centre of the slide, slowly, moving it outward, as the table turns, so that it shall not twice pass over the same spot, until you have formed a scroll-like circle with the juice, of about a quarter of an inch in diameter. Let the slide remain fifteen or twenty minutes, place a drop of fresh balsam upon the centre, and place upon it a half-inch cover-glass. Let the cover sink down slowly until it is in contact with the balsam, throughout. If not level, press it gently, so that the balsam shall fill out handsomely. Set it away, but do not heat it. Il will require some time to harden, but if in haste to use it, as soon as the balsam at the edge of the cover has hardened somewhat, run a circle of a solution of shellac in alcohol, so as to touch both the edge of the cover and the slide. This will hold all fast, even though the balsam be still liquid within. Finish this if you choose, at once, paints, with tube and your slide is done. Examine the slide by oblique (black ground) light, or far better, if you have it, by polarized light, use the green, not the purplish colored, "wandering jew,"—you will find the needles beautifully distributed, clean, and looking like polished steel. The needles are oxalate of lime, and are beautiful with polarized light.

S. A. Webb.

Oswego, N. Y., March, 1881.

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The Physics of Vision with the Compound Microscope.*

It is my purpose this evening to bring before you some of the results of the studies of Professor E. Abbe, of the University of Jena, Prussia, which have shown us, that in portraying the structure of objects, the dioptrical action of the lenses in a microscope, is very limited; and that, except in cases of very low amplification, the performance of an objective is dependent upon the physical nature of light and the structure of the object.

It may seem to you that the various points are discussed in a superficial manner, but it would be impossible to treat the entire subject of the physical action of the microscope in one short paper; I have endeavored, therefore, to give a practical bearing to my remarks, and to do this it has been necessary to cover a large field.

Moreover, the exhaustive treatise of Prof. Abbe is not yet published, and until this monograph is before us it is not possible either to explain or to fully understand a number of minor points in his theory. Still, there can be no doubt that his conclusions are correct, and that to him belongs the credit of having laid, after long and patient research, the foundations of a rational and true theory of the microscope.

There are objectives which work when nothing but air intervenes between the front lens and the object. Such objectives are known as dry-objectives. The theoretical limit of angular aperture for such objectives is 180°. It is very evident that this limit cannot be reached in practice; the greatest angular aperture that can be obtained with good performance with dry-objectives is not much above 110°. I cannot stop to explain why this limit is so low, but as a few makers have produced objectives for which they have claimed angular apertures far in excess of this figure, I will say that Professor Abbe's careful researches have shown that a well-corrected, dry lens cannot be produced, with the optical glass now made, with an aperture above 110°.

On the other hand, we have objectives which define only when some fluid intervenes between the object and the front lens. Such objectives are known as immersion objectives. The fluids used are selected on account of certain physical properties—density, refractive and dispersive power—those most commonly used are water and glycerin.

In such objectives a ray of light passing from the mirror, at an angle of about 41°, will suffer total reflection at the upper surface of the cover-glass if the objective is a dry one, but when an immersion lens is used the ray passes directly on, and enters the objective, only slightly changed from its original direction.

Thus we see that the available angular aperture for dry-objectives, for covered objects, is practically limited by the angle of the total internal reflection in glass.

If the front lens is connected with the cover by the fluid, it will be observed that this fluid need only possess a refractive index the same as the glass in order to conduct the incident rays in a perfectly straight line from the object to the objective. Thus, the immersion system makes larger apertures available than can be utilized with dry-objectives, besides diminishing the loss of light by reflection.

Quite recently objectives have been introduced that are made on the principle of homogeneous-immersion, that is, the fluid intermedium has a refractive and a dispersive power the same as the glass of the front lens; the light therefore enters the lens without refraction. This system has rendered it possible to greatly increase the angular aperture objectives, and, so far as the resolution of minute structures is concerned, the homogeneous-immersion

* Read before the New York Academy of Sciences, during the Winter of 1879–80.

objectives have far excelled any others. It was first practically introduced by Carl Zeiss, of Jena, who made lenses according to formulæ calculated by Professor E. Abbe, at the suggestion of Mr. John Stephenson, of London.

The compound microscope consists of two parts, an objective and an eye-piece or ocular. The objective collects the light from an object placed at its anterior focus, and forms an image of that object at the conjugate focus. This image is enlarged by the ocular. The combination of objective and ocular affords an image that is far more perfect than it is possible to obtain with a simple lens, even when the amplification is no greater than a simple lens would readily give.

Until within a very few years, it has been assumed by all writers on the microscope, that the magnified image in this instrument is formed according to dioptrical principles, such as govern the course of the light through a telescope; and even to-day there is no text-book that contains any information whatever, about the recent researches which have shown the fallacy of this assumption.* "According to the old theory, it was supposed that the image-forming rays which entered an objective underwent a series of refractions and formed an image of the object at the conjugate focus, then continued on to the ocular, which was so constructed that a certain over-correction of the objective would be neutralized, and the image was thus rendered free from errors of color. It was supposed that all structures, no matter how minute or delicate they might be, were imaged in this manner, by what is known as the dioptrical process.

Since many of the fine markings of diatom-frustules, which are easily resolved by ordinary lenses, are separated by spaces much smaller than the wave-length of blue light, it is difficult to understand how such markings could be imaged dioptrically. The objective and ocular were supposed to act together as one optical system, and it was assumed that the defects and imperfections of one, could be remedied by modifications of the other. According to this theory, the only purpose of the ocular was to add to the power of the objective; consequently, the theory afforded no explanation of the acknowledged superiority of the compound over the simple microscope. As to the aberrations, none but spherical and chromatic aberrations were taken account of in their simple forms. Generally speaking, when the definition in all parts of the field was good, and required no change of focus to make any part distinct, the glass was considered free from spherical aberration or curvature of field. The chromatic aberration was indicated by the color of the image, and the appearance of the borders.

(*To be continued.*)

* Nägeli und Schwendener's treatise on the microscope should be excepted.

EDITORIAL.

—Evidently *The Northern Microscopist* (London) has been canvassing for advertisements, for the last cover-page of a recent number bears the following card :—

"SOME HINTS ON ADVERTISING.—American paper-makers have not been slow to avail themselves of the newest and best ideas for improving their industry and developing their trade, but they have singularly neglected one fundamental principal of business, which the keen and pushing merchant finds of great practical value. Very few paper-makers consider the worth of advertising, and many forget that a journal devoted to their interests has claims upon them which they ought to acknowledge.—*Paper Trade Journal.*

For American paper-makers read English opticians in the above paragraph."

"The bearings of this observation lays in the application on it."

TRICHINÆ IN LARD.—There are strange rumors running through the newspapers of this city, about Trichinæ that have been found in lard. The *Herald* traces them to the authority of the same gentleman who has generously informed the public, through the columns of his own paper, that our Figure 9, printed last month, was a "wretched misrepresentation of free trichinæ." Now, we are willing to admit that our illustration is not quite perfect, but really we think the fault was not ours, since the cut was not engraved for this JOURNAL. At the same time, we believe that it represents trichinæ better than does any thing that can be discovered in lard.

—o—

FUNGI AND CONTAGION.—The article we publish this month from Dr. Salmon, who may well be regarded as one of our best authorities upon the subject which he treats, is the first of a series which he has promised to furnish for this JOURNAL. We are pleased to have such an excellent opportunity to present this confusing subject in a manner that will make it interesting and intelligible. The editorial comments to which the author alludes, and which have generally been adverse to the germ-theory, have been more especially directed against the unscientific and inconclusive character of most of the investigations, the greater number of which have been conducted by persons who were not qualified to carry on scientific research of such an extremely delicate nature.

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PROTOCOCCUS NIVALIS.—Mr. Eug. Mauler, of Switzerland, in response to a letter, has given us some interesting facts concerning this little-studied plant, the cause of the red-snow. It is only found within the limits of the eternal snows of the Alps, at a very great height, and is always associated with *P. viridis.* M. Mauler regards the red and the green cells as only different conditions of the same plant, but the transformation takes place very slowly, requiring a whole year. In the preparations of this alga that M. Mauler has kindly sent us, there are many spherical cells that were once of a bright-green color, no doubt, and an occasional smaller cell of a bright-red color, which is the *P. nivalis.* The green cells greatly preponderate in the specimens.

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MICROMETERS.—Prof. W. A. Rogers, of Cambridge, has at last completed his new dividing engine. This machine has been constructed at the works of the Waltham Watch Factory, under the personal supervision of the Mechanical Superintendent, Mr. Chas. V. Woerd, who has arranged all of its details. The construction has consumed three years, and the cost has been about $4,500.

The Waltham Watch Co. does not undertake to make dividing engines, but in this case the necessity for perfect workmanship was imperative, and upon the representation that it was undertaken in the interest of a useful scientific investigation, the Manager, Mr. R. E. Robbins, kindly consented to afford accommodations for its construction.

The extreme working length of the screw is half a metre. The theoretical limit of subdivision is about two billionths of a centimetre. The practical limit may be set at about one fifty-thousandth of a centimetre.

It is yet too early to say whether this machine will do all that is claimed for it; but Professor Rogers invites investigation, and, as we understand the matter, he is willing to furnish standards without cost, to any competent person who will make a careful study of the subdivisions, and who will at the same time agree to publish the results, without communication with him.

In order to meet a small portion of the expense incurred in the construction of the machine, Professor Rogers will, upon application, make standard micrometers, guaranteed to

be aliquot parts, either of the British Imperial Yard "Bronze 1," or of the "Mètre des Archives."

At present he will make the following patterns:

1. 101 lines .001 inch, and 101 lines .001 $^{cm.}$ with the first line in each common to both, price $2.00.

2. 301 lines, 100 coarse, 100 very fine, for high powers, 101 coarse, all .01$^{mm.}$ price $2.50.

3. 501 lines .01 ^{mm}, and 501 lines $\frac{1}{2500}$-inch, price $5.00.

4. 1001 lines .01 $^{mm.}$ and 1001 lines $\frac{1}{2500}$-inch, price $10.00

5. Same as the preceeding one but with both sets of lines double, that is, ruled both with fine and with coarse lines, price $15.00. In all the above, the 5th and 10th lines, are longer than the others.

We believe that these are the only micrometers that are perfectly reliable, and it is to be hoped that microscopists will show their appreciation of the work of Prof. Rogers, the value of which is far above any estimate of a commercial nature, by possessing themselves of one of his excellent plates.

The object in ruling the lines $\frac{1}{2500}$ of an inch apart is to permit of ready comparison with the .01^{mm} lines, these spaces being approximately equal. It will be seen that one band acts as a vernier to the other.

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Preservative for Algæ. — M. Paul Petit has experimented in order to obtain a preservative liquid for algæ, and has finally prepared one which seems to be quite satisfactory for the purpose.

It is composed as follows: Camphorated water and distilled water, of each 50 grammes, glacial acetic acid, .5 gr., crystallized chloride of copper and crystallized nitrate of copper, of each .2 grammes; dissolve and filter.

Preparations made with this liquid have retained their living appearance and green color after exposure to the direct light of day for a year. *Spirogyra*, *Ulothrix*, and especially Desmids (*Penium Nægeli* and *Micrasterias crenulata*), have long retained their freshness in the solution. It will be observed that the salts of copper have been made use of to preserve the color, just as they are, on a larger scale, in preparing legumes for the market.

We have long felt the need of a solution of this kind, and sincerely hope that M. Petit's solution will meet our wants. Our own experiments have not been productive of good results. However, the loss of color in our specimens has been a matter of secondary importance. The great difficulty with us has been to preserve the natural arrangement of the cell-contents, and after trying many of the solutions that have been recommended we have fallen back upon pure water, or water mixed, with about one-tenth of its volume, of strong lime-water. We propose to try M. Petit's solution immediately.

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Movement of Diatoms.—The contribution from Mr. Cox, which is printed this month, will doubtless lead many readers to give special attention to this curious phenomenon. It should be understood that the cause of the motion is now as mysterious as ever—no satisfactory explanation of it has yet been given. The presumption that it is the result of osmose is scarcely tenable, from a physical point of view. The phenomena of osmose depend upon differences in the density of two miscible fluids which are separated by a membrane, and they are apparently somewhat related to capillary phenomena. With very few exceptions, the prevailing flow is from the rarer to the denser medium, so that this action, if it took place in the diatoms, would tend in the wrong direction to produce motion of the frustules. Moreover, it is difficult to conceive of any physiological cause for the reversal of the current after it is once established in the natural direction. It can hardly be maintained that osmose

produces a true current, it is rather a result of molecular operations within the porous membrane. Even if it could produce a true current, we would still require to know how it could possibly be localized or caused to act in any particular direction. We are confident that a critical examination would convince any person that osmose cannot produce the movement of diatoms. The motion seems to be the result of physiological processes, and because it is obscure we should not accept untenable hypotheses to explain it. Osmose might as readily move a dead diatom as a living one.

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THE MICROSCOPE IN EDUCATION.—Mr. C. Henry Kain delivered a lecture on "The Use of the Microscope in Teaching," before the Camden County Teacher's Association. This is one among many indications that have lately impressed us with the idea that there is a rapidly growing interest among school-teachers in scientific subjects. There is no doubt that in proper hands the microscope could be made an efficient means of instruction. Mr. Kain has well expressed his views as follows:

"Microscopy is not an absolute science within itself. The great advantage of the microscope to the teacher consists in the fact that it wonderfully enlarges the scope of vision, giving the power to pry deeper into the structure of organized matter, and enabling us to know as facts many things which otherwise would be mere matters of theory. In the study of insects and plants the microscope is an absolute necessity. The lecturer described the curious breathing apparatus of insects, and also alluded to the wonderful adaptation of the various organs of insects to their particular uses, and necessities. Reference was also made to the necessity of using the microscope in giving instruction in physiology, a study now taught in most schools. It is easy to interest even young children in the study of their own wonderful organization, provided pains are taken not to render it too entirely theoretical. A single view of a structure is often better than pages of description. * * * The importance of interesting children in scientific study was spoken of, also the fact that a teacher who has succeeded in thoroughly interesting a child, is thereby unconsciously securing an immense hold upon the affections, thus often rendering even a troublesome pupil tractable, and readier to receive instruction in other things."

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NEW MECHANICAL STAGE.—Messrs. J. W. Sidle & Co. have written to us as follows concerning a mechanical stage:—

"The February issue of the *Journal of the Royal Microscopical Society*, gives a cut and description of Tolles' new mechanical stage. It struck us as good, and Mr. Sidle went to work, and, on paper, made a great improvement upon it. We were about to send it to you, and have you publish it quick, when lo and behold along comes the *English Mechanic* and we find Watson was too smart for us. Our ideas are exactly embodied in his patent. But we can beat that and will show you so in August, at Columbus and Cincinnati."

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AMERICAN MICROSCOPICAL SOCIETY OF THE CITY OF NEW YORK.—We copy *verbatim* the following remarkable circular:—

"Owing to a misapprehension, which appears to have been recently encouraged by interested parties, it has been deemed expedient to notify the friends of the American Microscopical Society of the City of New York—the oldest incorporated microscopical society in the United States—that the name of the Society *has not been changed, its meetings discontinued, or its large and valuable collection broken up and scattered.* At the recent annual election the following officers were elected for the year 1880 (1881?). President, John B. Rich, M. D.,

12 E. 22d Street, N. Y. Vice-President, Wm. H. Atkinson, 41 E. 9th Street, N. Y. Secretary, O. G. Mason, Bellevue Hospital, New York. Treasurer, T. d'Orimieulx, 7 Winthrop Place, N. Y. Curator, John Frey, Bellevue Hospital, N. Y. * * *

"Communications and packages for the Society should be plainly addressed to the American Microscopical Society of the City of New York, care of the Secretary, New York City, N. Y., O. G. Mason, Secretary."

We observe that some of our contemporaries have given publicity to this announcement, and for this reason, it seems proper to correct any "misapprehensions" that may arise therefrom. From such information as we have been able to obtain, from sources which we regard as authentic, it appears:

1. That the above-named society enjoys but a nominal existence.

2. That a considerable amount of valuable material, which accumulated while the Society was in a prosperous condition, is about the only element which now keeps the organization in existence.

3. It is the general opinion in this city, that there will be a "division of the spoils" when a favorable time comes.

4. That the above-named officers constitute almost the entire membership.

5. That no other members are desired.

The New York Microscopical Society now numbers about thirty-five members, and the interest in the meetings is constantly increasing.

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Life on the Seashore.—Mr. George A. Bates has published a small book, which forms the first of his "Naturalists' Handy Series," and which will prove very interesting to microscopists who visit the seashore, or who enjoy keeping marine aquaria. The full title of the book is "Life on the Seashore, or Animals of our Coasts and Bays," with illustrations and descriptions, by James H. Emerton. It is so rich in illustrations that are of real value to the amateur collector, and the information, and descriptions given are so appropriate to the wants of such persons, that we take pleasure in giving it our hearty commendation. While the author has not attempted to describe the more abundant animals in detail, and has consequently not found it necessary to devote much space to their microscopical characteristics, minute forms of life, the polyzoa, zoophytes, hydroids and sponges, have not been neglected, and in many cases the puzzling embryonic forms of the higher animals are described and figured.

Mr. Emerton must be an experienced collector, for he has certainly shown excellent judgment in the selection of his illustrations and in the descriptions, manifesting a full appreciation of what persons most desire to know, who are but slightly acquainted with marine life or general zoology.

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Collections.—With the opening of Spring we avail ourselves of the opportunity to urge our readers to begin early in the season to make collections, for, during the months of April and even sometimes in March, most interesting objects can be found which, later in the year, will either disappear or enter upon their purely vegetative stage of existence. The true student will not be deterred by chilly air or muddy banks from searching for the treasures of the ponds in early Spring. It is the prevailing opinion that during the Winter, when the ponds are covered with ice, there is nothing in them worth collecting. The keeper of an aquarium knows better than this, for, by cutting through the ice, healthy water-plants may be found, horn-wort, Myriophyllum, Anacharis, for example, and Volvox and Daphnia and Cyclops and many other forms of plants and animals can be collected with the dipping bottle.

By the time this number of the Journal is distributed, it will be

worth while to choose a bright sunny day and collect some of the water-plants, and to look them over in a bottle with a pocket lens. Probably numerous forms of Vorticellas will be found, with water-bears, Daphnias, and Rotifers, and after standing exposed to the light for an hour or two it is not unlikely that specimens of the interesting *Hydra viridis* will be found attached to the sides of the bottle.

We have often urged our readers to make collections and to send an account of their discoveries to the JOURNAL. It is not necessary to determine the species of the organisms, in order to make an instructive article about them. It is sufficient to mention the genus, and this can usually be done from the *Micrographic Dictionary*, or Pritchard's work, if it can be found. The object of writing about the organisms should be to rouse an interest in their study. Many a reader of this JOURNAL is within a few minutes' walk of a pond which teems with interesting objects, which would afford instruction for months, and yet they are never looked for. If a person becomes once thoroughly interested in these examinations, he is not likely to lose any opportunity to make collections. We urge our readers, therefore, to begin early, and to send us accounts of the habits of the organisms they find, even if their names are not known.

CORRESPONDENCE.

TO THE EDITOR:—Apropos to the discussion of the question: What has been accomplished by the modern wide angled glasses? while acknowledging that it has not been quite fairly thrust upon you, I think you will enjoy, and that good will be done, by putting side by side two short quotations, the first from the *Quarterly Journal of Microscopical Science* for 1866-67 (London), Vol. VII, N. S., p. 59, and the other from W. Saville Kent's new *Manual of the Infusoria*, p. 27. The first is as follows: "On the structure and habits of Anthophysa Mülleri, one of the Sedentary Monadiform Protozoa, by H. James Clark, A. B., B. S. We have before had to notice the careful studies of the author of this paper, who is devoting his energies to the most detailed study of single species of Infusoria. He observes, with perhaps a little more enthusiasm than accuracy, that the microscopes of the present day are to those of the past, what Cuvier's scalpel was to those of his predecessors, and believes that a vast deal is yet to be leart about the Infusoria by the use of the best glasses opticians can produce. This is possible; at present, however, we have not heard of a single discovery in biological science, acknowledged and confirmed as true, which may fairly be said to have been made by the use of a better glass than the quarter inch objective of many years' standing."

The second quotation is from the introductory part of Mr. Kent's admirable work, in which he is giving the history of the progress of scientific knowledge in regard to the Infusoria.

He says: –

"The following year (1868) commands a conspicuous position in the bibliography of the present subject, through its association with the discovery by professor H. James Clark, of the Agricultural College of Pennsylvania, U. S. A., of certain flagellate Infusoria exhibiting an entirely new type of structure, accompanied by his simultaneous announcement that all sponges consist essentially of colonial aggregations of similar flagellate animalcules." Yours Truly,

J. D. C.

CINCINNATI, March 19th, 1881.

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TO THE EDITOR:—In a vase of river water, which has been kept for over a year, I find growing from time to time, algæ often difficult to procure *in situ* and in quanties sufficient for proper study. Just now there are quantities of *Gonium pectorale* of the family Volvocineæ which I have never before seen. Its flat, quadrangular cœnobium is well marked with its regular 16 cells, 3 at each side and 4 in the centre, each having two long, vibratile flagella by means of which it rolls about with a rapid motion. Along with this I have found of the Protococcus family *Scenedesmus acutus* and *Ophiocytium cochleare*, both of which are rare in this vicinity. Neither the first nor the last are mentioned by Wood.

A. F. K.

OTTAWA, Canada.

NOTES.

—Mr. James L. English, Epping, Essex, England, is soliciting subscriptions for a work that he proposes to publish, entitled "A Manual for the Preservation of the Larger Fungi (Hymenomycetes) in their Natural Condition, by a new and improved method." The price is seven shillings and six pence. The fungi prepared by Mr. English have been greatly admired by such eminent mycologists as the Rev. M. J. Berkley and C. Muller.

—Messrs. J. W. Queen & Co.'s *Illustrated Catalogue of Optical Instruments*, for 1881, contains over 180 pages, and is a useful pamphlet for reference. Among the articles recently introduced, we notice Queen's "Tourist" Microscope, which packs into a space about 6½ by 3¾ by 2⅜ inches. This instrument in its simplest form sells for $15.00.

—*Papilio* is the name of a new periodical which is the organ of the New York Entomological Club. It is devoted exclusively to the Lepidoptera. The first number was issued in January, and illustrated with a fine colored plate. It is to be issued monthly, except during two midsummer months. The subscription price is $2.00.

MICROSCOPICAL SOCIETIES.

NEW YORK.

The Annual Reception of the New York Microscopical Society, was held on the evening of February 14th, at the rooms of the New York Academy of Sciences. The annual address was delivered by the President, Mr. Romyn Hitchcock, who had chosen for his subject "The Relations of Science to Modern Thought." At the conclusion of the address many beautiful objects were shown under microscopes, and explained by the members; the interest in the objects was greatly enhanced by the descriptive programme which accompanied the invitations. Among them were to be seen the well-known *Trichina spiralis*, the circulation of the sap in the cells of *Nitella* and *Vallisneria*, and a living spider revealed more beauty than most persons were prepared to find in that object. The ciliated cells from the gills of a clam, were shown in the living condition; the constant lashing of their hair-like projections produced currents in the water, and in the living animal they thus maintain a circulation of water through the gills. A fine specimen of the "globigerina ooze" that was collected from the bottom of the sea, by the *Challenger* expedition, in 1876, was also exhibited. Perhaps the most beautiful objects of all, were the group of insect-eggs and the slide of insect-scales and diatoms, which had been arranged to represent a vase of flowers with insects hovering about it—a striking specimen of artistic skill and patience. The circulation of the blood through the web of a frog's foot was also shown.

At the meeting of March 4th, the President made the following report: At a meeting of this Society last December, Mr. H. S. Woodman exhibited some peculiar objects that he had found attached to stones, hoping that some member might be able to give some information as to its nature. Feeling an interest in the subject, I requested Mr. Woodman to let me have the specimens for examination. He did so, but it was only last week that I found a convenient time to study them, and I now bring the subject before you.

Viewed upon their face, as they naturally stand upon the stones, the objects appear very much like discoid diatoms with coarse radiating markings, but much larger than diatoms. A cluster of them would make a beautiful object for the cabinet. A careful examination shows that their form is cup- or bowl-shaped with a short pedicel. Within the white outer shell, there is a spherical body of a fine red color, which I take to be an egg. When this was examined in water and a slight pressure applied on the cover-glass the red contents, consisting of a granular fluid and red corpuscles, somewhat larger than human blood-cells, slowly exuded, but as it seemed to be of an oily nature it did not mix with the surrounding water. The shell is granular chitinous, and not very brittle. I conclude that the objects are eggs, probably of some insect.

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ONEIDA COUNTY (Utica, N. Y).

The regular monthly meeting of this Society was held at its rooms Monday evening, February 28th. Dr. Smith Baker read a paper on the "Microscopical Uses of the Cat." The paper was a plea for

the more universal use of this superfluous domestic animal, in microscopical study.—He deplored the seeming preference displayed by most authors of microscopical literature for the rabbit and Guinea pig, as proper material for experiment, and proceeded to show how much the cat is to be preferred to either of these comparatively expensive animals for studying the tissues and organs. He also gave a full and complete description of the operation of injecting, and the subsequent operations of hardening, cutting and mounting. The paper was illustrated by a large number of neatly mounted, injected and stained sections of the tissues of the cat. Other members of the Society also exhibited mounts, bearing upon the subject of the paper, and after the reading the evening was occupied in examining and discussing the various objects. Mr. Mallory was appointed to read the paper at the next meeting.

GEORGE C. HODGES, Secretary.

SAN FRANCISCO.

At a meeting of this Society, held some time ago, Mr. Hanks described "The Clays in the Comstock Lode." The article was quite long and possesses hardly sufficient general interest to admit of its publication in this place. It is, however, a valuable article for those who are interested in the study of the disintegration of rocks, the condition of minerals in their veins, etc., and copies can doubtless be obtained from the author.

WELLESLEY COLLEGE.

The regular meeting was held Monday evening, February 28th. The President, Miss Hayes, in the Chair.

Miss de Veny presented a paper on sponges.

Miss Alice Gold also gave one on shells, illustrated by shells and drawings.

Professor Whiting spoke about snow-crystals, illustrating her remarks by original drawings, with some remarks as to the supposed causes of crystallization.

Under the microscope were exhibited:

1. Sponge Spicules. Three different slides.
2. Microscopical shells displaying most of the generic forms.
3. Copper thrown from a volcano.
4. Crystals of chlorate of potash.

L. F. CLARKE, Cor. Secretary.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides.*
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

Well-mounted diatoms, in exchange for ***any well-mounted slides*** or material, etc.
W. H. CURTIS, Haverhill, Mass.

For diatoms *in situ* on Algæ, send mounted slide
K. M. CUNNINGHAM, Box 874, Mobile, Ala.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Fine injected specimens of kidney, tongue and liver, also very fine slides of human tooth, prepared according to the method of Dr. Bödecker, showing the protoplasmic net-work between the dentinal canaliculi, in exchange for first-class histological and pathological slides, or other good specimens.
J. L. WILLIAMS, North Vassalboro, Me.

Slides of hair of *Tarantula*, very curious; also crystalline deposits from urine, to exchange for well-mounted slides. S. E. STILES, M. D.,
109 Cumberland St., Brooklyn, N. Y.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

Diatomaceæ from Lake Michigan (Chicago water supply), mounted or raw material; also diatoms from other localities, to exchange for well-mounted Diatomaceæ or other objects of interest. B. W. THOMAS,
1842 Indiana Ave., Chicago, Ills.

Lime sand, composed almost exclusively of microscopic Foraminifera, to exchange for microscopic material. H. A. GREEN, Atco, N. J.

Polyzoa, Palates of Mollusca, Foraminifera, Sponge and Holothurian-Spicules, Synapta-Anchors, Chirodota-Wheels, Echinus-Spines, Minute Sea Shells, in exchange for Polyzoa, Foraminifera, Histological and Pathological preparations, *etc.* Also, a quantity of Sea Shells in exchange for Land and Fresh-Water Shells.
F. M. HAMLIN, M. D., Auburn, N. Y.

To exchange, well-mounted Slides of Hair for mounted or unmounted specimens of hair from the rarer animals; lists exchanged. WM. HOSKINS,
208 S. Halsted street, Chicago, Ill.

Slides mounted from injected Frog's Gall-bladder, Liver, Kidney, Stomach, Intestine and other parts, exchanged for other good and interesting preparations. C. BLASDALE, M. D.,
Jericho, Queens Co., N. Y.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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Charbon and the Germ-Theory of Disease.

BY D. E. SALMON, D. V. M.

II.

At times it has seemed that many scientists were playing fast and loose with the germ-theory, in a style not very consistent with the elementary principles of scientific reasoning. On the one hand, the mere presence of bacteria in the blood or other liquids of man or animal, affected with a contagious disease, has been accepted as a proof that the disease in question was caused by bacteria; but as such organisms were found in various non-specific affections, and, indeed, were shown to be universally present, and the difficulty of separating the pathogenic from the septic forms and of proving the effect of the former is so great, that there has been a reaction which leads many at present to utterly reject the germ-theory. However, such varied opinions should hardly excite surprise in regard to a subject of which so little is known, for there are always some who reach the most positive conclusions from the very slightest evidence.

Now, I am convinced that these extreme views must be modified before we arrive at the truth; of themselves, however, they are not evidence either for or against the germ-theory. In science a fact must be demonstrated before it can be accepted, and when once properly established, it must remain a fact, no matter what results are attained by other lines of investigation. In other words, facts do not contradict each other, and when they appear to do so, it is only because our knowledge of the subject is superficial. This principle seems to have been neglected, however, by many of those who are discussing the etiology of charbon; and, now, after a demonstration has been made of the pathogenic action of the *Bacillus anthracis*, we are continually being told that this demonstration must go for nothing because results attained through other lines of research appear to some to be inconsistent with this fact.

If these points are unduly insisted upon, it is because it seems necessary to be positive in regard to these fundamental principles; but it is not my intention to disregard other observations or the conclusions which may be reasonably drawn from them. Facts must agree, no matter by whom discovered, and I shall not set the example of suppressing any of them. We will, therefore, consider the observations which are believed by some to conflict with the germ theory as applied to this disease.

1. THE BACILLUS ANTHRACIS IS NOT ALWAYS FOUND IN THE BLOOD OF ANIMALS WHICH HAVE DIED OF ANTHRAX.—Although it is manifest that septicæmia has been frequently confounded with charbon,* I am willing to accept it as a fact that there are some unmistakable cases of charbon in which the *Bacillus anthracis* cannot be found in the blood by direct microscopical observation; and

* L. Pasteur, Communication to Paris Academy of Medicine, July 17, 1877; also, *Recueil de Médecine Vétérinaire*, 1877, pp. 763–4.

it at once becomes a question whether this fact is in opposition to the conclusion we have reached in regard to the pathogenic action of this organism.

When animals are inoculated hypodermically with charbon virus this does not seem to be absorbed by the blood vessels, but by the lymphatics; that is, the *Bacillus anthracis* multiplies in the areolar tissue and progresses slowly towards the lymphatic glands; when these are reached, its progress is arrested until the inflammation which it produces causes sufficient changes in the gland to allow it to pass; when another gland is reached, the same process is repeated, and it is often a considerable time before the bacterium reaches the blood.* During this time the products formed by the bacteria are carried into the circulation, as well as an increased amount of waste products of the animal tissues caused by the inflammation of the lymphatic glands, by the increase of white corpuscles and by a general increase in the activity of the bioplasm of the whole body. The occasional result of this increase of waste products, in nearly all contagious diseases, is death in the early stages from chemical poisoning; it can hardly be doubted that in charbon death may occur either before, or, at least, very soon after the bacilli have reached the blood.

It is further maintained by some, however, that blood in which the bacilli cannot be found may produce charbon by inoculation; and that the disease so produced has all the characteristics of charbon, including the bacilli. From this it is argued that the bacteria are an epi-phenomenon, having no connection with the virus, and being dependant upon the condition of the blood. Pasteur has given an explanation of this which is in the highest degree satisfactory. When there are but a few bacilli in each drop of blood, he says, it is extremely difficult to find them, for a drop pressed between the thin cover and the slide has a diameter of three-fourths of an inch, and as we must use a power of 500 or 600 diameters, our field of vision is reduced to about $\frac{1}{100}$ of an inch in diameter, giving in the drop, if I have calculated correctly, 5,625 microscopic fields. It is, consequently, next to impossible to say positively that there is not a single organism in the drop, if we rely upon microscopic examination alone. But Pasteur has demonstrated that whenever the inoculation of a drop of blood produces charbon, the cultivation of another drop in a sterilized infusion suitable for its growth will produce a crop of the *Bacillus anthracis*.* It seems to me, therefore, that there is nothing here to cause any one to reject the plain evidence advanced in regard to the relation of the organism to the disease, since the presence of the bacillus may be always demonstrated, by cultivation, in virus that is capable of causing charbon.

2. Bert's experiments.—It cannot be denied that the experiments of M. Bert were altogether the worst bombshell ever sent into the camp of the believers in the germ-theory; and our antagonists evidently had a keen appreciation of this, for years after this investigator had recognized his conclusions as erroneous, they have continued to use them against the new theory. M. Bert used charbon blood that had been sent to him from Alfort; this he subjected to the influence of oxygen under a pressure of fifty atmospheres. As this blood still destroyed Guinea-pigs, it was coagulated with three times its volume of absolute alcohol, added drop by

* Report of Committee which adjudged the Bréant prize to G. Colin. *Comptes Rendus*, XCII, p. 599.
H. Toussaint, Recherches Expérimentales sur la Maladie Charbonneuse. Paris, 1879, pp. 98–9.

* L. Pasteur, Letter to M. Bouley. *Recueil de Médecine Vétérinaire*, 1877, p. 917.

drop; the coagulum was well washed with alcohol and dried *in vacuo*. This dried coagulum yielded its virulent principle to water, from which it might be again precipitated by alcohol in the form of white flakes; and although these flakes no longer killed dogs, they were fatal to three successions of Guinea-pigs. Even after being preserved five months in alcohol this virus was still capable of destroying these animals. It appeared impossible, at the time, to draw any other conclusion than that the virus was a soluble, formless ferment comparable to diastase.*

It must be admitted that this conclusion seemed trustworthy; at the time it appeared impossible to explain the result of these experiments in any other way; but there was a direct antagonism between this result and that previously reached by Koch. Many of us felt discouraged and feared that, notwithstanding the most perseverant efforts, the subject was destined to remain surrounded by an impenetrable veil; but a few, who had not lost their faith in the possibilities of scientific investigation to conquer all difficulties, were certain that this antagonism was only apparent, and waited patiently for the solving of the enigma. They had not long to wait, for Pasteur at once took up the question and convinced M. Bert, in less than two months, that the results above stated did not conflict with the germ theory; and M. Bert read a second communication before the Académie des Sciences in which he satisfactorily explained what had before been such a mystery. He found that blood containing the bacillus rods alone, or urine in which these were cultivated, lost all virulence both by the action of compressed oxygen and by that of alcohol—the death of the organism always meant death of the virus. Pasteur and Joubert had just shown that the spores of bacilli and vibrios may resist both of these agents; did this not explain how the disease was produced by his preparations? To assure himself, he examined the flakes which formed upon the addition of alcohol to the water that had been charged with the first coagulum; these contained numerous bright granules, identical in dimensions, form and appearance with the spores. These granules, placed in a proper cultivation-liquid, developed into long filaments, and thus the proof of their nature and vitality was complete; while the serum from Guinea-pigs that had died from inoculations, though extremely virulent, when filtered through plaster, gave a filtrate that might be inoculated with impunity, showing conclusively that the disease was not due to a soluble chemical poison or formless ferment. In conclusion M. Bert says: "It appears to me, then, absolutely demonstrated that the blood with which I experimented contained not only bacteridia, but septic vibrios, the corpuscle-germs of which have resisted the alcohol as well as the compressed oxygen, the adult organisms having, on the contrary, succumbed to both of these agents."

M. Bert was completely satisfied, as was every candid man, that his experiments, instead of opposing the germ-theory, really confirmed it; but some of the highest medical authorities in England, after having access to his second paper, either refused to accept the latter part of the evidence,* or quoted that part of the observations which told against the germ theory, and entirely suppressed the remainder.†

3. GREENFIELD'S EXPERIMENTS.—It seems to be established by Professor

* P. Bert. De l'emploi de l'oxygène à haute tension comme procédé d'investigation physiologique: des venins et des virus. *Comptes Rendus*, May 21, 1871.

* T. R. Lewis. The Microphytes which have been found in the Blood and their Relation to disease. *Quart. Journal Mic. Science.* 1879; pp. 373–5.

† J. L. W. Thudichum. *Annals of Chemical Medicine.* London, 1879; pp. 231–2.

Greenfield that, by his method of cultivation, although the bacillus retains its vitality and morphological characteristics, it completely loses the power of producing disease after the twelfth generation. This fact we are all willing to admit; but it seems absurd to bring it forward at this late day, as some are doing, to show that charbon is not due to this organism; before Koch's observations were made, it might have been accepted as having a bearing in that direction, and would undoubtedly have been a severe discouragement to the followers of the germ-theory; but now, when the connection of the bacillus with the disease is demonstrated, it is useless to expect scientific people to barter an established fact for what is, at best, but a faint indication.

Nägeli has long held the view that the pathogenic bacteria are simply septic bacteria, which have been acclimated in some way and thus enabled to grow in the blood and tissues of living animals.* This opinion was the result of studies of the septic forms, which he found could be changed gradually from organisms that produce one kind of fermentation to others that produce a fermentation of an entirely different kind, and they then almost lost the power to live under the conditions which were at first extremely favorable to them. Acting upon this theory, Dr. Buchner was able, by a series of very ingenious experiments, carried out in Nägeli's laboratory, to confirm Greenfield's results and to transform the *Bacillus anthracis* into the harmless *Bacillus subtilis* or "hay bacillus;" he was also able to reverse this process, and change the *Bacillus subtilis* into the *Bacillus anthracis* with all its virulence.†

* C. v. Nägeli. Die niederen Pilze in ihren Beziehungen zu den Infections-krankheiten und der Gesundheitspflege. München, 1877.

† Dr. Hans Buchner. Ueber die experimentelle Erzeugung des Milzbrandcontagiums aus den Heupilzen. München, 1880.

4. Toussaint's experimemts.—In his first communication, this gentleman stated that fresh anthrax blood which had been heated to 55° (131° F.) might be inoculated on susceptible animals without causing disease, and that it had the property, when so inoculated, of protecting such animals from the effect of subsequent inoculations with virulent blood. It was believed that the bacilli were all destroyed at this temperature, and that the acquired immunity resulted from the introduction of substances which had been formed by them.

In this a fact and a theory were combined, and some of those who are so fond of criticising the germ-theory seemed unable to comprehend where the one stopped and the other began; I think all were willing to accept the former, but some of us refused to believe the latter until better evidence was furnished. This was fortunate, for when M. Toussaint came to try his experiments on a larger scale, he was obliged to recall the theoretical part of his first statement. Twenty sheep were inoculated with the prepared virus at Alfort, of which four died of charbon, while all the remainder were sick of the same disease, but recovered. The heat, therefore, certainly reduced the activity of the virus, and caused it to produce a milder form of disease; but the immunity conferred was demonstrated to be the result of this mild form of the malady, and not to the introduction of an inconsiderable quantity of a chemical substance.*

Pasteur's latest researches.—Since the above was written, I have received the *Comptes Rendus de l'Académie des Sciences* for February 28th, 1881, in which M. Pasteur communicates his latest researches in regard to the charbon virus. He had previously discovered that the action of atmospheric oxygen for a number of months (five to eight),

* *Comptes Rendus*, XCI, pp. 457–8.

destroyed the organism found in the virulent liquid of fowl-cholera subjects, and that during this period the virulence became progressively weaker, causing a milder form of disease, until, towards the last, and while the organism still retained its vitality, its virulence was entirely lost. Charbon virus was then investigated in the light of these facts. It was evident that the effect of atmospheric oxygen must be tried upon the rods, for the spores were known to retain their virulence unchanged for years. To prevent the formation of spores, the cultivations were made at a temperature of 42° to 43° C., at which point the organism multiplies by division of the rods without the formation of spores. Such a cultivation after standing a month in contact with pure air loses all vitality, and the organism transferred to fresh liquid is no longer capable of reproduction; the day before, however, and every preceding day its vitality was still retained, as was proved by its growth in such new cultivations. The virulence is entirely lost after the first eight days that the bacillus is kept at this temperature, and during these eight days the virus passes through progressive degrees of attenuation. When a bacillus was thus obtained which had lost all virulence for the Guinea-pig, rabbit and sheep, it was found that its powers might be restored by cultivating it in the bodies of certain animals. It would still destroy a Guinea-pig but one day old, though it had no effect on one of six days, and by passing it through several successions of the former, it was soon able to destroy animals three to four days old, then those a week, a month or several years old, and, finally, the sheep itself. The organism had entirely regained its original activity.

Having reviewed the recent investigations of charbon, somewhat hurriedly it is true, it must be admitted that there is no contradiction, no inconsistency to be found in them; we see a rapid increase in our knowledge of the pathogenic agent, which promises much for the future in regard to the whole class of the contagious diseases; but this advance has directly followed from a study of the *Bacillus anthracis*. The obscure points in regard to the preservation of the virus, its introduction into the body and its action on the organism have been made perfectly intelligible by the germ theory, and it is impossible to explain them on any other hypothesis.

Before concluding, and at the risk of repetition, I offer the following facts which prove the pathogenic action of the *B. anthracis*.

1. The one-hundredth cultivation of the *B. anthracis* in a harmless liquid, if made under favorable conditions, is as virulent as the fresh charbon-blood.

2. When the *B. anthracis* is removed by passing virulent liquids through a plaster filter, these liquids lose their activity.

3. Virulent matters containing rods only, lose their activity in a few days if dried.

4. Such matters containing spores retain their activity an indefinite time when dried.

5. Virus containing rods only, soon loses its activity if deprived of oxygen.

6. If these rods have formed spores, the activity is retained indefinitely, though deprived of oxygen.

7. Putrefaction destroys virus which does not contain spores, if the access of oxygen is restricted.

8. When there is sufficient access of air to allow formation of spores, putrefaction has no effect on the virus.

9. Virulent liquids containing rods alone, lose their activity by being largely diluted with distilled water.

10. The addition of water has no effect on the virulence of liquids containing spores.

11. Virulent liquids, in which the bacillus has not formed spores, lose their activity in a few days if kept at 8° C.

12. If spores have formed, such liquids may be kept at this temperature indefinitely, and retain their original activity.

13. Virulent liquids containing rods alone, lose their activity when treated with compressed oxygen.

14. Such liquids in which spores have formed, are not affected by this agent.

15. The virulence is also destroyed by concentrated alcohol before spores have formed.

16. After spore-formation this agent has no effect on the virulence.

We have here a series of sixteen facts, showing the connection between the activity of charbon-virus and the presence of the living *Bacillus anthracis;* these facts have been observed and confirmed by the most accomplished investigators of the time, and I take it for granted they are entirely reliable. If they had all been announced by one man, we would be perfectly justified in making certain reservations before accepting them; but when we have the united testimony of such men as Koch, Cohn, Buchner and Nägeli among the Germans; Pasteur, Toussaint and Bert in France, and Greenfield in England, it is not becoming to express doubts of their accuracy when we have not even one scientific observation to support us.

Accepting these observations as facts, I maintain there is no longer a shadow of doubt that the bacterium in question is the essential cause of the disease, and that it is the active agent, and the only active agent in the virus.

This being the entering wedge for the germ-theory in scientific pathology, it is perfectly right to demand the most conclusive evidence before admitting it; but this evidence has now been furnished—the germ-theory has a substantial foundation—and medicine is destined to make its most brilliant triumphs by the discoveries to which it will lead. The progressive pathologist will waste no more time in criticising what is so well established, but will press onward to other and equally important discoveries.

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Photographing Bacteria.

The method of staining bacteria for photographing, described in the last number of this JOURNAL (p. 53), is doubtless an improvement upon Koch's method of staining with anilin violet, for, as there stated, the violet gives very little photographic contrast, because it permits the actinic rays to pass. A method which I have employed with success, and which, so far as I know, is new, is the following:—

The bacteria are dried upon a slide or upon a thin glass cover, and are then treated with commercial sulphuric acid, a drop of which is placed upon them. After two or three minutes the acid is washed off by a gentle stream of water, and the bacteria are then covered with an aqueous solution of iodine (iodine, grs. 3; potassic iodide, grs. 5; water, grs. 500). After a few minutes they will be found to present a deep-orange or brown color, which gives the desired contrast in a photograph-negative. I have only found this method useful for extemporaneous preparations which are to be photographed immediately. According to my experience the color fades after a time, and the bacteria undergo changes in form (swelling) as a result of this treatment, which renders the method unsatisfactory when the object is to make a permanent preparation. For this purpose I have found nothing better than the anilin violet, which, indeed, leaves nothing to be desired when a collection is being made without reference to photography. I am in the habit of mounting my speciments either in solution of acetate of potash (Koch's method) or in carbolic acid water, and I prefer the last named fluid.

Anilin violet ink, which may be

obtained from any stationer, is a cheap and satisfactory staining fluid. One or two minutes immersion in this is usually sufficient time to give the bacteria a deep violet color. Those who have not resorted to this method will be astonished at the facility with which it is practiced and with the variety of forms which may be demonstrated at a moment's notice, without a resort to culture-experiments or to a search in ditches and sewers. The mouth, the rectum, the extremity of the urethra in the male, and the vagina in the female, are constantly supplied with an incredible number of these minute, vegetable organisms, and a great variety of forms may be observed, especially in the discharges from the bowels. The slightest possible smear of saliva scraped from the surface of the tongue, of vaginal mucus, or of fecal matter dried upon a slide, stained with violet ink and washed with a gentle stream of water, will furnish ample material for study and will serve as a practical demonstration of the extensive distribution of the bacteria. To obtain a satisfactory view a good $\frac{1}{8}$-inch objective will be required, and for the smaller species a lens comparable to the $\frac{1}{12}$-inch of Zeiss is desirable.

Bacteria may often escape observation, not only because of their minute size, but because they may have very nearly the same refractive index as the fluid which contains them. Assertions, therefore, as to their *not* being found in certain secretions, etc., will have but little value unless it is shown that this or some other efficient method of staining has been resorted to, and the objective employed is mentioned.

GEO. M. STERNBERG,
Surgeon, U. S. Army.

BALTIMORE, Md.

[Dr. Sternberg has sent us a number of photograph-prints of different objects prepared according to the method described above. Although he states that they do not show his best results, they certainly give evidence of the real excellence of the process. Among them is one of *Bacterium termo*, which is usually regarded as an exceedingly difficult object to photograph. The organism is well portrayed, magnified 1,500 diameters. Some swarm-spores of an alga are remarkably well-shown, as are also some other cells which are designated as *Protococcus.*—ED.]

The Physics of Vision with the Compound Microscope.

(*Continued.*)

According to Professor Abbe's theory, the objective and ocular must be regarded as two pieces of apparatus, perfectly distinct from each other, both as to their construction and functions. For a thorough understanding of this subject, it will be necessary for the microscopist to dispossess his mind of the common idea that the objective and ocular are so intimately combined in the compound microscope, that the faults of one can be corrected by alterations of the other. One fact which lies as the very foundation of this theory, is that the objective forms the image and the ocular merely spreads that image over a greater area, magnifying the faults without correcting them. With our present knowledge and materials, it is not possible to construct either a perfect objective or ocular. There are certain faults inherent to the methods now employed for correcting aberrations, although some recent experiments of Professor Abbe, in which he made use of lenses filled with fluids having various refractive and dispersive powers, have shown that very perfect correction would be possible, by well-known methods, if we could obtain the proper materials. The limited time only permits me to allude to a few of the imperfections. Both chromatic and spherical aberrations are

corrected by placing a system of strongly over-corrected lenses above or behind a front lens that is under-corrected. When we consider the varying inclination of the rays of light which enter a microscope-objective, especially an objective having a large angular aperture, the difficulty, in truth, the impossibility of correcting the chromatic aberrations of all the rays from the axial to the marginal ones, will be evident. Apart from the necessary residual chromatism of the system, due to the irrational dispersion of the two kinds of glass, the different angles of incidence greatly complicate the problem of perfect correction. Spherical aberration cannot be eliminated, for in attempting to correct the aberrations of an under-corrected lens by a powerfully over-corrected system, residual errors will always be found. Since perfect achromatism cannot be obtained, it is evident that the images produced by rays of different colors will each be of a different size from the others. It is also true that there is a difference between the magnification of axial and peripheral rays, so that a certain amount of distortion is produced. The same effect is far more noticeable in the ocular, for there the variation of amplification is considerable. Nevertheless, the faults of the most perfect objectives are so great, relatively to the imperfections of the ordinary ocular, that it is useless to attempt to improve the performance of an objective by carefully corrected oculars. I do not mean to assert that the improved or patented oculars, such as the "orthoscopic," periscopic and "solid" eye-pieces possess no points of superiority over the common form, for this is not true ; their superiority, however, is apparent mainly in an increased field, or in diminished loss of light by reflection from surfaces, but they cannot render visible details of structure, which an ordinary ocular would not show.

We pass now to the consideration of the action of an objective in forming an image of an object. For this purpose we will consider the object to be the siliceous covering of a diatom known as *P. angulatum*. When this object is placed in the focus of a good objective, and viewed with the eye-piece the outline is clearly seen, and also the median line. This outline-image is formed in accordance with the ordinary dioptrical rules. But in looking into the microscope we see more than the image of the diatom. There is a circular "field of view" which is also an image—an image of something external to the microscope, it may be an image of the source of light, of the mirror, of the diaphragm, but it is truly an image and it must be regarded and studied as such ; for in this image, in connection with the images of objects in the focus of the objective, all the imperfections of the dioptrical action of the objective may be detected. This aperture-image, together with the object-image, may be studied in detail in two places, viz. : in the upper focal plane of the objective, or just above the eye-lens of the eye-piece. It may be studied with the naked eye, or with the aid of an examining lens. The diameter of the aperture-image is determined by the angle of divergence of the external cone of rays which enters the objective, and the focal distance. Any ray proceeding from the focal point of an objective is found in the aperture-image at a distance from the axis that may be measured by the equivalent focal length, multiplied by the sine of the angle which the ray forms with the axis. It follows from this that there is a direct relation between angular aperture and the diameter of the aperture-image. It also follows that the exact course of any ray of light can be followed by means of the aperture-image. The objective collects the rays of light which diverge widely from the object, the various lenses gradually change the direction of the rays until they become parallel,

after which they issue from the back surface of the posterior lens converging to form an image at the conjugate focus, where they cross and again diverge. As previously observed, it is customary to say that the objective forms a real image which is magnified by the ocular, but when we regard this as the entire process we simply assume that the only result of combining ocular and objective is an increase of magnifying power. The true statement is, that the function of the objective is to focus the function of the eye-piece is to magnify. The superiority of the compound microscope over the simple lens is primarily due to the division of labor which is thus indicated. The two functions are so entirely distinct from each other, that the inherent imperfections of one cannot be corrected by imperfections purposely introduced in the other. As already observed, in one plane within the objective, just before the rays undergo the final refraction at the back surface, the rays are proceeding in a parallel direction. The part of the objective engaged in producing this result, acts therefore, like a simple lens forming an image at an infinite distance. These parallel rays could be collected by a suitable telescope. We may consider the focussing function of the objective as complete when this infinitely distant image is formed. The posterior part of the objective may then be regarded as the object-glass of a telescope and the ocular as the eye-piece of the telescope. We would then have a clear conception of the action of the microscope, the objective first forming an infinitely distant image, which is then magnified by a telescope consisting of the posterior portion of the back lens of the objective and the ocular. By placing a suitable lens in front of an ordinary telescope, the telescope becomes a microscope.

When we recognize the specific focussing function of the objective, we will at once remark the uselessness of any accessory for correcting its aberrations. Dr. Royston Pigott's "aplanatic searcher," an instrument devised to correct residual aberrations, which aroused no little interest in England at one time, failed to accomplish the purpose. The amplifier, about which much has been written, only serves to increase the magnification ; it does not add to the optical capacity of the microscope, for it can be clearly shown that for every objective there is a certain amplification that can easily be attained by lengthening the body-tube, or by deeper eye-pieces, which will render visible to a normal eye, every detail which the particular objective can resolve ; and no further increase of magnification can do more than to make the same details larger. The explanation of this fact will be given in another place. Returning now to the diatom with which we started, if we use a suitable objective we will see not only the aperture-image, and the dioptric object-image already mentioned, but in addition there will be seen a series of close parallel lines called striæ, and these can be made still more distinct by proper management of the light, or even resolved into series of minute dots. Under these circumstances, if we examine the aperture-image we find no trace of the lined or dotted structure, although the outlines are clear and sharp as before. However, in certain parts of the field, the precise position depending upon the direction of the illumination, one or more spectra are visible, the blue color being nearer the axis than the red. A thorough study of the spectra, and of the aperture-image, proves that the decomposition of the light is caused by the diffractive action of the minute markings of the object. The diffraction-spectra which are seen in the aperture-image are the only indications, there present, of minute markings on the object. The researches of Professor Abbe have shown that

the diffraction-spectra alone enable us to resolve minute structures, and that this resolution takes place independently of any dioptrical action of the microscope. Precisely how the interference-lines due to diffraction become combined with the dioptric image, so as to represent the markings of the object when the eye-piece is applied, I will not attempt to explain; it will suffice to say that this conception of the action of the microscope, and every conclusion to which it leads, is fully sustained by mathematical analysis and is perfectly in accord with the wave-theory of light. However, I will mention a few experiments which are easily made, and which seem to fully demonstrate the correctness of the theory. Arrange a series of diaphragms in, or very near to, the upper focal-plane of the objective, in such a manner that any one or more of the spectra can be shut off from the eye-piece at pleasure. If all the spectra are thus shut off, only those parts of the object will be seen that are imaged by the dioptric beam—not a trace of any lined or dotted structure finer than $\frac{1}{2500}$ of an inch (11μ) can be seen, although the outlines and grosser parts are well defined. In the case of a diatom-frustule, the markings are invisible, while its shape is clearly portrayed, but in the case of close lines ruled on glass, there would be no image whatever, because there is nothing about such rulings to give a dioptric image—no outline. For this reason Nobert's test-plate is not so good a test-object as diatom-frustules. On the other hand, if the spectra are all admitted, the minute markings of the object are distinctly seen, thus proving that the resolution of these lines is entirely dependent upon the spectral-images. Moreover, as a still further demonstration that the finer details are not resolved as the ordinary theory assumes, we may entirely shut off the dioptric beam, without affecting the definition of the minute structure, but then the outlines will be totally lost. It will be understood, therefore, that no minute structural details can be seen with a microscope, unless the diffraction rays from the object enter the objective to form the spectral-images.

The finer the markings of an object are the greater is their diffractive action, hence, the more the incident rays are changed from their original course, and, consequently the wider the angular aperture of the objective must be in order to receive them. Therefore, the limit of the resolving power of an objective is fixed by its angular aperture entirely, for when the structure becomes so very fine that the diffracted rays pass outside of the aperture, it is impossible for the objective to resolve it. We are thus led to a conclusion regarding the capabilities of the microscope, and we are able to determine the limit of its resolving power. It is evident, then, that the power of resolution is a function quite distinct from, and independent of, magnifying power.

It is well known that a certain angular separation of points or lines is necessary to enable a normal eye to distinguish them. Therefore, if an objective is capable of resolving a series of lines, by virtue of its angular aperture, those lines will certainly be visible when the eye-piece is sufficiently powerful to give them the angular magnification that is necessary for distinct vision. Hence, for a given angular aperture of an objective, which limits its power of resolution at a certain point, there is a corresponding angular magnification, to be attained by the eye-piece, that is necessary to make the lines visible. No further increase of magnification, obtained in any way, can make any more details visible, or in any way add to the optical capability of the instrument. The necessary angular amplification can be easily converted into terms of linear magnification. We are thus led to the conclusion that there is a limit to the

capabilities of every compound microscope, that can be definitely expressed in figures, and that this limit primarily depends upon the angular-aperture of the objective.

I will now call your attention to the fact that the images of minute objects which the microscope gives are no proof whatever of the real constitution of the object. Many years ago it was observed that the microscopical appearance of an object could be greatly changed by altering the conditions of illumination, and this fact gave rise to much discussion about the structure of certain insect-scales and the nature of the fine markings of diatoms. On one side it was held, that because changes in the illumination and delicate alterations of the focus produced such positive differences in the image, it was impossible to demonstrate the structure of such objects by means of the microscope. For example, there was no means of determining whether the dots upon the diatom-frustules, or the markings on the podura-scale, were elevations or depressions, for they could be made to appear either light or dark by turning the focussing screw. On the other side it was maintained that the perfection of the image in the microscope, when the best objectives were used, was ample proof that the structure was correctly delineated; and this, I believe, is the prevailing impression at the present time. However, we have already learned that the diffractive action of the object determines the character of the image, and we must therefore conclude that the apparent excellence of this image is no criterion from which we may infer the real structure of the object. As a matter of fact we can prove, by direct experiment, that this is true. For example, we may rule a series of lines upon glass in such a manner that the diffractive effect will be identical with that of *P. angulatum*. The image of these lines formed by the microscope will be undistinguishable from that of the diatom; and the same will be true of any object which gives the same diffraction spectrum, whether it be a series of ruled lines or of minute particles, or any structure whatever.

When *P. Angulatum* is examined with a certain kind of illumination, we will see a series of lines running directly across the frustule; by changing the direction of the illumination the lines will appear to be inclined to their original direction, and by still further manipulation the lines can be made to disappear, and sharply-defined dots will take their place. When the focussing-screw is changed, the dots will change from dark to light, or the reverse. All these appearances can be perfectly reproduced by substituting a glass slip, with two series of lines crossing each other at an angle of 60°. It is by the use of artificial test-objects, such as rulings on glass, the exact nature of which is known, that we are able to verify the deductions from theory. Perhaps the most striking evidence that we have of the unconformability of the image with the structure of the object, is to be found in the fact that when we examine a ruled plate, having a known number of lines in a given space, it is possible to cut out some of the diffraction spectra, so that the number of lines in that space will be doubled in the image. In such an experiment it is impossible to distinguish the false lines from the true; for both depend upon the physical action of the object upon the light, and neither image is a real image, in the ordinary acceptation of the term.

In conclusion I desire to say a few words about the bearing of the facts which have been brought forward. It is discouraging to the scientific investigator, who uses the microscope, to learn that no skill, no care or judgement will enable him to always distinguish the true from the false. Nevertheless, this is precisely the position of the microscopist, whenever he

undertakes the study of minute markings. I have already referred to two objects particularly, the scales of *Podura* and the siliceous frustules of *P. angulatum*, not because the uncertainties were any greater about these objects than about others, but because they are familiar as test-objects; and what has been said of them is also true of all objects of the same kind. Hence, the exact nature of the markings of all diatoms and insect-scales must be made out by supplementing the ordinary microscopical examination with experiments of a different nature.

To bring the bearing of the discussion nearer to the field of work in which some of the members of the Academy are engaged, I would remark that the nature of the so-called "striped" or "striated," muscular fibre cannot be positively determined by direct examination with the microscope. The "net-work" of the blood-corpuscles, which was described before the Academy by Dr. Elsberg some time ago, is shown to be, in all probability, an optical illusion, and the recent investigations of Klein and Flemming on the structure of nuclei, are without value, so far as any proof of the existence of a minute network is concerned. Dr. Ephraim Cutter, of Boston, in the course of a paper read before the Academy, described some appearances in blood-corpuscles, when examined with a $\frac{1}{75}$-inch objective made by Mr. Tolles, of Boston. I have never known any more striking instances of misinterpretation than some that were embodied in that paper, and while I cannot admit that they were entirely due to the imperfections of the objective, I am convinced that such extraordinary powers as the $\frac{1}{75}$- and the $\frac{1}{50}$-inch are practically worthless. Unquestionably, the results of the thorough study which Professor Abbe has undertaken will throw doubt upon many observations of a nature kindred to the above.

The question will arise, to what extent can we rely upon the results of microscopical work? Practically, I do not believe that many cases will arise in which the microscopist will be at a loss for a means of testing his work and verifying his results. Thus, the fractured frustule of a diatom may reveal its structure, and the nature of the markings upon the podura-scale has been fully determined by the use of electric current, which detached the spines, and thus proved that they were just what they appeared to be. It is true that it is not always possible to do this; hence, there will always be some room for argument and doubt. However, apart from such comparatively few instances as these, the evidence of the microscope is reliable. There can be no doubt that every detail that is imaged dioptrically is correctly pictured. It is true that close lines or dots cannot be resolved with the same assurance of accuracy, but it must not be forgotten that the great end of microscopical researches is not the resolution of close lines and dots. Indeed, it is rarely that the microscopist who works on other objects than diatoms, insect-scales and test-plates, has occasion to employ the utmost powers of the instrument in such resolutions. On the contrary, most of the work done with the microscope, is of a nature that requires excellent dioptrical definition combined with sufficient angular aperture to define minute markings and isolated lines or particles, and there can be no question raised about the existence of the isolated particles or lines which are portrayed. The flagella of certain bacteria, which, if my memory serves me right are not more than 1-200,000 of an inch in diameter, can be clearly distinguished, and there can be no question raised as to their existence.

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A Home-made Erector.

I desire to call the attention of those readers of the JOURNAL who are endeavoring to make every

dollar go as far as possible in the purchase of accessory apparatus for their microscopes, to the fact that if one of the right-angled prisms which are used around chandeliers be held horizontally over the eye-piece, with the widest face from the observer, and the image viewed through it, that, after the two refractions and one reflection, the image will appear in its normal position; and that if the prism be held in exactly the right position, the definition will be but slightly, if at all, impaired. It would not be a very difficult task for any one possessed of a little mechanical ingenuity to break off a short piece of the prism and arrange a support for it over the eye-piece, removing, if necessary, the cap. This device would be of great service to those desiring to dissect or to manipulate material under the compound microscope, and would obviate the necessity of spending from four and a half to eight dollars.

An erection of the image may also be secured by the interposition of an objective at the end of the draw-tube and immediately above the working objective, but at a great sacrifice of definition.

W.

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An Excellent Method of Cleaning Diatoms.

The application of the bi-sulphate of potassa in cleaning diatoms has already been recommended twice in the columns of this JOURNAL. I would now offer some additional hints as the result of my experience in its use. It is applicable to the treatment of nearly all varieties of diatomaceous material. Proceed as follows: Crush to powder a few crystals of the bi-sulphate of potassa, and add to it a proportionate quantity of the material to be cleaned; mix intimately together, and transfer it to a hollow space practiced in the end of a sound piece of charcoal. Then with the blow-pipe direct the flame of a candle upon the mixture, when a violent boiling up will ensue, and when it finally ceases to fuse readily, when the potash appears opaque and of a whitish color, it is to be removed and dropped into a thimbleful of water, and boiled a few seconds; the potash dissolves readily, and liberates the sand and diatoms in a cleaned state. After settling in a shallow porcelain saucer, draw off all the water and collect the diatoms into the smallest compass possible, and transfer them to a nickel; take the nickel in the wire tongs, and dry with blowpipe flame; it will dry immediately, and the diatom powder is to be scraped off and put aside for use.

All the requisites for the above process consist of a common dime blow-pipe, a small wire tongs six inches long to hold the thimble, nickel, etc., a pocket coin, a brass thimble, a few pieces of sound charcoal, a candle, and a small supply of the bi-sulphate of potassa.

When the bi-sulphate cannot be readily procured, an admirable substitute may be found in the following, viz.: common powdered sulphate of potash, and a small quantity of sulphuric acid, both of which are always found in prescription drugstores. In using these materials, the diatoms to be cleaned are mixed with an equal quantity of the powdered sulphate of potassa, and a few drops of sulphuric acid are mixed with it; it solidifies at once, and can be broken into suitable pieces to be fused on the charcoal, as before described. The superior advantages of the processes here described will become apparent to those who have tried the acid methods of cleaning.

K. M. CUNNINGHAM.

EDITORIAL.

—O! Dr. Marvin, how could you print that very sarcastic squib last month? Don't you know that our worthy "Brother" has enough to answer for already? Yours was "the most unkindest cut of all."

—A large number of our subscribers are behind with their subscriptions, some for last year have not yet been paid. We would respectfully request prompt attention to this little matter—to be sure it is an insignificant thing to refer to in this prominent place, and it savors more of business than of science, still, we are not averse to doing a little business now and then.

We quote the following extracts from the postal laws concerning subscriptions:—

"Any person who takes a paper from the post-office, whether directed to his name or another, or whether he has subscribed or not, is responsible for the pay."

"If a person orders his paper discontinued, he must pay all arrearages, or the publisher may continue to send it until the payment is made, and collect the whole amount, *whether it be taken from the office or not*. There can be no legal discontinuance until the payment is made."

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CEDAR APPLES OF THE UNITED STATES.—The *Anniversary Memoirs* of the Boston Society of Natural History, just issued, contain a contribution from Prof. W. G. Farlow on "The Gymnosporangia or Cedar-apples of the United States."

The Gymnosporangia constitute a genus of parasitic fungi belonging to the order Uridineæ, or rusts, among which the names *Puccinia*, *Uredo* and *Æcidium* are familiar. At the present time, most mycologists regard the forms which received these generic names in the past, as having a genetic connection with each other. Thus, the name *Puccinia graminis* was originally given to the blight on grass which appears as dark colored spores, formed of two, more or less conical cells, united at their bases, and attached to a mycelium. It is now considered that this so-called teleutospore condition represents only one stage in the growth of the fungus. These spores are produced in the autumn. The following spring they germinate; each cell gives off one, two or three delicate, short filaments which become divided by transverse septa into a number of cells. The upper cell grows out laterally, and bears a small, ovoid cell which falls from its attachment. The filaments are known as promycelium, and the ovoid cells are called sporidia. The sporidia only germinate on the barberry, where they produce the well-known *Æcidium berberidis* or cluster-cup, which is no longer regarded as a distinct plant, but merely as a stage in the growth of *P. graminis*—the hymeniferus or æcidial condition. The æcidium is produced in May or June. The æcidia produce spores which germinate upon different grasses and form the uredo stage of *P. graminis* which formerly was designated as *Uredo linearis*. The spores from the uredo condition (called stylo-spores) germinate, and in the autumn produce the teleutospores already described. We have thus briefly reviewed the life-cycle of one species of *Puccinia*, as given by Prof. Farlow, but it should be borne in mind, that while it is not improbable that the other species will be found to assume similar stages in the course of their growth, it has not yet been demonstrated that they do.

In the genus Gymnosporangium, which differs from Puccinia in its gelatinous nature, only æcidia and teleutospores are known. The teleutospores are usually two-celled, and are borne on long, hyaline stalks, imbedded in masses of jelly which swell in moist weather into orange colored masses, by many supposed to be the flowers of the cedar-trees. Oersted, De Bary, Cornu and others have connected this gelatinous, teleutospore-stage with certain forms of cluster-cups, generically known as Roestelia, found on leaves of different Pomeæ—thorns, apples, pears, etc. Nevertheless, Prof. Farlow's investigations have failed to establish any such connection between the Gymnosporangii and the Roestelia of this country. They tend, rather, to cast some doubt upon the relationship

between those forms which the eminent mycologists above mentioned claim to have demonstrated. Eight species of Gymnosporangium and the same number of Roestelia are fully described. The article is illustrated with two fine lithograph-plates.

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PARASITES OF THE TERMITES.—This is the title of a valuable contribution from Prof. Joseph Leidy, published in the *Journal of the Academy of Natural Sciences*, of Philadelphia. It is illustrated by two large quarto plates.

The Termites or "white ants" are represented by a species common in New Jersey and in the vicinity of Philadelphia, known as *Termes flavipes*. It is found in dry, sandy forests and fields, and is frequent beneath decaying timbers, discarded railroad ties, etc.

The intestinal canal contains a brownish, semi-liquid food, which swarms with myriads of parasites; the parasites, indeed, constitute the greater portion of the contents. It would seem, as Prof. Leidy suggests, that the termite simply fulfills the part of a disintegrating mill which reduces the ligneous food to a pulpy condition, adapted to the delicate constitution of its parasitic inhabitants, the welfare of the host being of comparatively little consequence. When we consider the vast number of parasites which each termite supports, it is not strange that its appetite should be ravenous, and that the insect should be destructive to houses, furniture and books. A number of new species of parasites are described in the article, but we cannot satisfactorily present their characteristics. We can do no better than to close this brief notice by the following quotation:—

"Termites, or White-ants, are so common, easily obtained and preserved alive, and their parasites are so exceedingly numerous, constant in their occurrence, and curious, that once the fact becomes sufficiently known, the insects will become favorite subjects to illustrate at once the infinity of life and the wonders that are revealed by the microscope."

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BACTERIA.—In a late number of *Science* there is a short article giving a *résumé* of the results of experiments by Mr. F. Hatton, on the action of various gases upon bacteria. The original article was read before the London Chemical Society, and, although the synopsis before us is less complete than we would wish to enable one to form a just estimate of the bearing of the experiments upon the physiological relations of the bacteria, it seems to be established that those organisms can exist under circumstances that are usually regarded as quite inimical to either animal or vegetable life.

In one experiment, which continued fifteen days, in atmospheric air, 20 per cent. of oxygen disappeared, but only 17 per cent. of CO_2 was formed. When the liquid containing the bacteria was placed in an atmosphere of hydrogen for fourteen days, the gas was found to contain 0.34 per cent. of CO_2 and 98.92 per cent. of H. In ten days pure oxygen was found to contain 29.98 per cent. of CO_2 and 70.02 per cent. of O. Sulphurous anhydride did not destroy the organisms; at the end of fifteen days the gas was found to contain CO_2 7.87 per cent., N 2.13, and SO_2 90.10 per cent. Cyanogen seems to prevent the growth of bacteria; but, under the conditions of the experiment, this gas became decomposed, forming ammonic oxalate and other compounds, after which the organisms revived. A somewhat remarkable result is announced from an experiment made with spongy iron and air. In four days the bacteria had disappeared, and, on the fifth day, an analysis of the air gave 0.26 per cent. CO_2, 99.74 per cent. of N., while the oxygen had entirely disappeared. Acetylene, salicylic acid, strcyhnine (10 per cent.), morphine,

narcotine and brucine exerted no effect upon the bacteria. In commenting upon these results, Mr. Hamlet stated that he had found that bacteria could live in 1 per cent. creosote, phenol, methyl alcohol, chloroform; and Grace-Calvert had shown that they could live in strong carbolic acid.

These results are decidedly different from what would have been anticipated. They indicate that bacteria are not so easily destroyed as we have been accustomed to assume, although it has long been patent to scientific observers that much of our fumigation and disinfection is inefficient to destroy living germs. The article referred to would certainly be more valuable, from a scientific point of view, if we understood the morphologicol relations of the bacteria that were present in the fluids during the experiments. It may be of interest, in this connection, to refer to the article published in this JOURNAL on page 214 of Volume I.

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SOME NEW SLIDES.—We have recently had the pleasure to examine a box of slides prepared by Mr. David Folsom, of Chicopee, Mass. The objects were insect preparations, principally mouth-parts, in which Mr. Folsom seems to excell. Without wishing to depreciate the value of many of the slides which have been in the market for years, by the most experienced mounters, we have no hesitation in stating that, in our opinion, there are no preparations to be obtained that are more carefully made than those of Mr. Folsom, and we take pleasure in giving this commendation to the intrinsic value and the real merit of his work in this direction.

Among the specimens we have seen, perhaps the most interesting, is a series of probosces of insects, some of which are not common—the proboscis of the queen honey-bee for example.

We are not aware that Mr. Folsom, has made any special efforts to introduce his slides to the public, although it is his intention, we believe, to prepare them for sale.

We trust that our readers will show their appreciation of the very excellent work of Mr. Folsom, by obtaining some of his slides for their cabinets.

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DEATH OF MR. NOBERT.—Mr. John Mayall, Jr., is the author of the following notice which appeared in the London *Times* of March 17th: "At the last meeting of the Royal Microscopical Society the announcement was made of the death of Mr. F. A. Nobert, of Barth, Pomerania, the well-known optical physicist, whose rulings of fine lines on glass have, for many years past, been regarded as marvels of dexterity by the scientific world. Mr. Nobert's fame is especially connected with the production of test-plates for the microscope, particularly the plate known as the 19-band plate, on which successive bands of lines are ruled of increasing fineness of division, from the rate of 1,000 to the Paris line to 10,000 (equal approximately to 112,000 to the English inch). It was formerly Mr. Nobert's opinion that the last four bands of his 19-band plate would never be seen resolved in the microscope. This opinion he was constrained to withdraw after careful inspection of photographs of the whole series of bands by Dr. J. J. Woodward, of the Army Medical Museum, Washington, U. S. A., from which an accurate count of the lines actually ruled was made by Dr. Woodward, and admitted by Mr. Nobert. Mr. Nobert then proceeded to make a new plate of 20 bands of lines varying from 1,000 to 20,000 to the Paris line. The lines on the tenth band, in this latter plate, correspond, in fineness of division, to the 19th band of the former plate. The microscopists of the future have, therefore, Nobert's legacy before

them to resolve the lines on the later test-plate. Mr. Nobert was extremely reticent as to the method of producing his fine rulings, and it is doubtful if he has communicated to any one the secret of his process of making and adjusting the ruling points."

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KLEIN'S ATLAS OF HISTOLOGY.—The title of this work conveys no adequate idea of its comprehensive character. The fact that those microscopists in this country who are interested in the subject, have had little or no opportunity of learning anything about it from the American press, leads me to beg the privilege of using a little of your space, to briefly outline to the readers of your JOURNAL a few of the many valuable features of this monument to the thorough knowledge of one of the leading English histologists, E. Klein, M. D., as well as to the artistic skill of the most expert medical draughtsman of the present day, E. Noble Smith.

The work is not, as the name would imply, a mere series of illustrations with brief descriptions; but, so far as our present knowledge permits, it is a complete instructor, both literal and pictorial to the student of histology, furnishing him with a standard of excellence, at which he may aim in the preparation of tissues for microscopical examination. The illustrations represent specimens, colored and uncolored. The former, stained by different reagents which are all specially mentioned in the description of the figures. The uncolored figures generally represent fresh, or unstained specimens, or in a very few cases are copied from other authors. Nearly all of the illustrations in the 48 plates, with upward of 500 figures, have been carefully selected from preparations made by Dr. Klein himself, which is a sufficient guarantee of their excellent adaptation, to illustrate the points in question. Besides his great skill, the artist has exhibited a full knowledge of the subject by selecting choice parts of the slide for representation. The text, besides a full explanation of the illustrations themselves, furnishes the student with a comprehensive, concise and modern account of the histology of man, as understood by the ablest observers down to the year 1880. It informs him concerning what is fully understood, and in other cases clearly states the uncertainty and point out the way for the student to investigate for himself.

In the language of the *British Medical Journal:* "The text is full of accurate, recent, and lucid information. It is long since any work of more entirely satisfactory conception and execution has issued from the English medical press. This is very high praise; but the rare merits of this standard production deserves no less."

The subject-matter is treated (to quote from the preface), in the following manner: "First the elementary tissues, blood, epithelial and endothelial, connective tissues, muscular tissues, the nervous, vascular and lymphatic systems. After which the compound tissues are treated seriatim, the alimentary canal and its glands, the respiratory organs, the skin and special sense organs." In the last chapter but one Dr. Klein has treated of those organs, the nature of which is but little known, the thyroid and coccygeal glands, and the supra-renal capsule. The final chapter and lower half of the last plate, is devoted to a description and illustration of the indirect division of the nucleus of the epithelial cells, which has been noticed by so many modern observers, both in animal and vegetable cells. A description of the process of indirect division, and the peculiar arrangement of the reticulated protoplasm of the nuclei during this, is well described and figured by Dr. Klein, in the new histology, as seen under a modern high-angled homogeneous-immersion objective. If any of the readers of

the JOURNAL care to observe these peculiar changes, they can be well seen in the epithelial of the newt, if they will take the trouble in the spring to get the eggs hatched, and rear the young, and, at different stages of their growth, to make picric acid preparations from the tail. The value of killing the animal and soaking the tissues with picric acid is that it acts upon the protoplasm, fixing it instantly as nothing else I am acquainted with will do; as will be shown by the naturally distended blood vessels and well preserved corpuscles, but more especially by the fixed reticulation or "intranuclear net-work" of the epithelial cells.

The claim made by some of high authority, that picric acid preparations will not take and retain carmine stain, is a mistake, for I have, and so have others here, preparations that have been mounted a long time that show the carmine stain as brilliant as when first mounted, and far more brilliant than the alcohol preparations of some of the complainants about picric acid.

A. A. B.

CORRESPONDENCE.

TO THE EDITOR:—Some five years ago I received a specimen of diatomaceous matter from my correspondent, Mr. G. Morehouse. It proved to be almost pure *Cocconies placentula*, epiphytic on a minute, filamentous alga. The alga was so completely covered with the epiphyte as to be itself nearly invisible. In this state it made an interesting study of the mode of growth of this group of diatomaceæ.

A few months ago I placed a portion of the material in water, in which it has been macerating until recently. Then it was slightly washed with soap, put into dilute alcohol, a pippet drop placed on a cover, heated, and mounted in Canada balsam. The result was unexpected. The vegetable matter was partly removed, entirely in many places, leaving the diatoms clean and brilliant, but the bulk of them remained adhering together in the same position as when they encrusted the filament, as tubes made up of the diatom frustules in all positions. Being transparent, the filament having dissolved away, a much larger number are now visible, thus affording a new opportunity for the study of their growth, which, however, could not have been understood, if they had not first been seen in their natural state.

If this material had been prepared in the usual manner with chemicals, the frustules would undoubtedly have been detached from each other. It is usually understood that the diatoms secrete a mucous covering. We may infer from this instance that while the mucous is destroyed by chemicals, it is not removed by simple maceration in water, but that it causes the adherence of the diatoms in their natural relation to each other.

CHARLES STODDER.

NOTES.

—Dr. T. F. Allen, of this city, has made use of a solution for mounting algæ, characeæ, etc., which preserves the arrangement of the cell-contents in a most excellent condition. The solution is prepared as follows:

1. Wood-vinegar, sp. gr. 1.04, 100 pts., salicylic acid, 1 pt.; shake, and allow to settle. This mixture is named "salicylic vinegar."
2. For algæ mix salicylic vinegar, 1 pt., glycerin, 1 pt., water, 20 pts.
3. For infusoria mix salicylic vinegar, 1 pt., glycerin, 10 pts., water, 40 pts.

—The liberality and coöperation of the Woman's Education Association enables the Boston Society of Natural History to announce that a Sea-side Laboratory, under the direction of the Curator, Mr. Alpheus Hyatt, and capable of accommodating a limited number of students, will be open at Annisquam, Mass., from June 5th to September 15th.

Annisquam is situated on an inlet of Ipswich Bay, on the north side of Cape Ann, and is about three and a-half miles by coach from the Eastern Railroad Company's station in Gloucester. The purpose of this Laboratory is to afford opportunities for the study and observation of the development, anatomy and habits of common types of marine animals under suitable direction and advice. There will be therefore no attempt, during the coming summer, to giving any stated course of instruction or lectures.

Terms.—$3.00 per week for periods of two weeks or less, $1.50 per week for periods of three or four weeks, and $1.00 per week for all periods exceeding one month.

—At a meeting of the Iowa State Medical Society a section of microscopy was formed, with the understanding that if a sufficient number of persons interested in microscopy, who are not medical men, should become interested in the matter, to justify the organization of an independent society, then the section of microscopy would resolve itself into an independent society.

The next meeting of the Iowa State Medical Society will be held in Dubuque, commencing on the last Wednesday in May, 1881, at 10 o'clock. All persons interested in microscopy, whether medical men or not, are hereby invited to come and bring their microscopes, etc., with them. Many men throughout the State have microscopes, but, not considering themselves microscopists, may leave their instruments at home. We are all novices in the work, but are trying to cultivate an interest in microscopy. Bring what you have. We wish to have all the microscopes we can possibly collect.

J. J. M. ANGEAR, President,
Fort Madison, Iowa.
W. D. MIDDLETON, Secretary,
Davenport, Iowa.

MICROSCOPICAL SOCIETIES.

ONEIDA COUNTY (N. Y.)

A regular monthly meeting of this Society was held in its rooms, March 28th. The paper of the evening was read by Mr. Mallory. Subject: "The Selection of a Microscope." The reader commenced by saying that to recommend the stands of any one maker, to the exclusion of others, would be a most difficult and thankless task; not only because of the slight difference in point of excellence between the stands of first-class makers, but also by reason of the new forms of stands yearly designed for special investigation. Then followed a series of hints on the selection of a stand. In regard to objectives, it was, in the opinion of the readers, the best economy to buy first-class objectives at the outset. In conclusion, Mr. Mallory advised to buy only the best when you do buy, and take good care of it when you have bought it. An animated discussion took place at the close of the paper. Rev. Mr. Whitfield, a manufacturer of optical instruments, made a few interesting remarks regarding objectives, and also spoke of a very ingenious stand he had seen at Troy, made entirely of paper and wood; he also described a coarse adjustment he had seen at Mr. Tolles in Boston, consisting of two wheels with V-shaped peripherys, at a short distance apart on the same spindle, working into two grooves. The motion communicated was very delicate and uniform. The speaker had never seen this adjustment on any stand in the market. Dr. Deeke, of the State Lunatic Asylum, described the large stand now used by him at the Asylum, which was furnished with double rack and pinion, he claimed entire freedom from lost motion, and great ease of movement from this arrangement. Prof. Chester gave a brief description of the most desirable instrument of low price now in the market. A vote of thanks was tendered to Mr. W. H. Walmsley, of Philadelphia, for a gift of his unsurpassed mounted objects, which, in the words of the donor, are intended as the nucleus of a cabinet. Dr. Deeke was appointed to read the next paper before the Society.

GEORGE C. HODGES, Secretary.

FAIRFIELD (IOWA).

On November 19th, 1880, six gentlemen organized a Society in this city for the study of microscopy, to be called "The Fairfield Microscopical Club." A Constitution and By-laws were adopted, and, under the Presidency of Prof. Albert McCala, of Parson's College, interesting monthly meetings have been held. The Club is quite prosperous.

At the March meeting a number of visitors were present. Prof. Wm. Lighton opened the evening with a selection from Chopin on the piano. After the usual business was transacted, a paper on "The Relation of Microscopy to the Study and Practice of Medicine," was read by Dr. R. J. Mohr.

A number of objects, mounted by Dr. Mohr, were then exhibited on the various stands, in illustration of the paper of the evening.

Dr. Mohr also exhibited a Bulloch's Congress Stand.

LIVERPOOL (ENG.).

The fourth ordinary meeting of the thirteenth session of this Society was held at the Royal Institution on Friday,

April 1st, 1881; Dr. Carter, President, in the Chair.

The Hon. Secretary announced the donation of twelve microscopic slides from A. C. Cole, Esq., London, Hon. Member, and the *Journal of the Quekett Club*, from the Club.

The President then called upon Mr. Mayall, Jr., F.R.M.S., for his communication on "Brass and Glass."

Mr. Mayall said that it had recently been most ungenerously stated in public that the "Brass and Glass" party, among the microscopists, cared for nothing but mere display of elaborate apparatus; that they vied with each other in encouraging the manufacture of more and more expensive instruments for the gratification of their personal whims and fancies, and without the slightest reference to advancing any scientific branch of microscopy. It was no part of his programme to explain in detail what really was expected to be gained by encouraging opticians to construct stands, objectives, condensers, etc., which, from their elaboration, must necessarily be costly; but he might point generally to the fact that the most conspicuous developements in recent microscropy—particularly the delineation of microscopic objects by means of microphotography—were absolutely dependant on the perfection of the instrument. Now the improvement of the instrument itself was, by no means, so petty a subject as it had been insinuated. He (Mr. Mayall) thought that a thorough investigation of the principles upon which the improvement of the instrument depended was, by no means, an unworthy or idle task; and he thought that if those principles were more generally appreciated, much more rapid strides would be made, and certainly there would be far less publicity given to crude and erroneous interpretations; the ground would, in fact, be cleared of much mere controversial verbiage. Taking as an example the prevalence of erroneous views, with regard to the meaning and function of aperture, he would endeavor to present to the meeting a clear statement of the old theory of this matter, and meet it point for point by the newer views, of which Prof. Abbe, of the University of Jena, was the originator. Then, by means of a large number of diagrams which he drew on the black-board, illustrating his subject, Mr. Mayall dealt at considerable length on the main features of what he termed the "aperture controversy," concluding his remarks on that branch by an earnest appeal to all present, if they had any difficulties to suggest them forthwith, as it was the ardent desire of himself, and those with whom he was associated in the controversy, to have every point of difference thoroughly explained, their sole motive being the promulgation of accurate ideas. Mr. Mayall also exhibited and described in detail several specimens of "Brass and Glass," some of which he commended to the notice of the meeting, whilst of others he said, "the least said the better." Among the former were Tolles's microscope, with vertical disk for the lateral rotation of the substage, with two stages of novel construction; Ross's new mechanical stage; Crouch's "students" microscope, with approximately frictionless fine adjustment; Parkeschild's portable microscope, etc., etc. In conclusion, a hearty vote of thanks was accorded to Mr. Mayall.

The meeting terminated with the usual *conversazione*.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond. Va.

Section of Brain, stained, showing Tubercular Meningites; also Carcinoma Cerebri. Please send list.
L. BREWER HALL, M. D., 27 South 16th Street.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoœ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides*.
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

Well-mounted diatoms, in exchange for *any well-mounted slides* or material, etc.
W. H. CURTIS, Haverhill, Mass.

For diatoms *in situ* on Algæ, send mounted slides.
K. M. CUNNINGHAM, Box 874, Mobile, Ala.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Slides of hair of *Tarantula*, very curious; also crystalline deposits from urine, to exchange for well-mounted slides. S. E. STILES, M. D.,
109 Cumberland St., Brooklyn, N. Y.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

VOL. II. NEW YORK, JUNE, 1881. No. 6.

On a Parasitic Structure Found in Eubranchipus Vernalis, Verrill.

BY DR. CARL F. GISSLER.

Numerous specimens of *Eubranchipus* were found infested with small, roundish corpuscles. They were densely packed together in several layers, and filled out the entire body, post-abdomen, claspers, anterior antennæ and the branchipeds. They were whitish disks visible to the naked eye; they measured 45^{μ}–50^{μ} in diameter, and about 15^{μ} in thickness. In alcoholic specimens their interior constituted a granular, coagulated plasm with three or four larger, central groups encircling a finer granulation. I found but two disks with an entirely black centre, and many without any cellular aggregation in the centre.

The cyst, or capsule in which they were enclosed, is a dense and structureless cuticle; a face-view of these disks exhibits five distinct rings of the cuticle; but after having prepared them in different mediums, I found that those rings were but an optical illusion, due to the elevated margin of the disk.

Whether this endoparasite is of vegetable or animal origin is hard to say; it may be an encysted infusorium or one of the encysted, developmental stages of a fungus.

Dr. O. Bütschli figures and describes* a parasitic structure with four distinct concentric walls and radial lines arranged between the rings. He found it in the posterior portion of the chylus-tract of *Porcellio scaber*. This, to my knowledge, is the only parasitic form similar to the one in question.

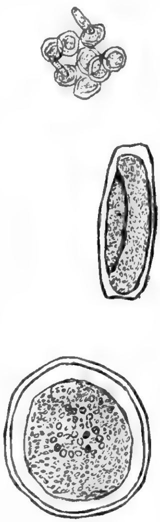

FIG. 23.

Eubranchipus vernalis (Fig. 23) is a beautiful, branchiopod crustacean, a sort of fresh-water shrimp, and occurs during the winter months only.* In the Winter of 1879–80 I fed sixteen frogs with infected *Eubranchipus*, and kept them in a damp cage to examine their intestines, etc., after some two or three mouths; but they all died after about fifteen or seventeen days, and nothing extraordinary could be found at the post mortem examination.

Although not successful in the single experiment, it is possible that in spring, when all individuals of *Eubranchipus* die and their bodies decay at the bottom of ponds, the parasite becomes free during the process of decaying and enters another cycle of life, probably as an amœboid or fungoid organism. Some individuals of this second generation may become imbedded in ice, and like many parasitic helminths, may propagate only

* *Archiv für Naturgeschichte.* 38 Jahrgang, 1, Heft, 1872, p. 248, Taf. IX, fig. 3.

* See *American Naturalist*, 1878, p. 186; 1880, p. 531; 1881, pp. 136 and 280. *Scientific American*, April 9th, 1881.

when introduced into a warm-blooded animal—for instance, man. Other individuals will enter the body of early, larval stages of *Eubranchipus*. Those individuals introduced in some way or other into the human body may enter another life-cycle, and may then find the most favorable conditions for their propagation.

———o———

Brachionus Conium—A New Rotifer.

BY H. F. ATWOOD.

7-1000ths of an inch.

DORSAL.

VENTRAL.

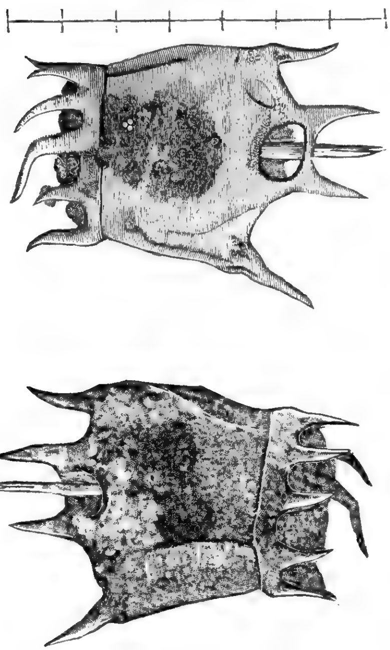

FIG. 24.—*Brachionus conium*.

In a filtering of Hemlock lake-water (Rochester's water supply) made in August of last year, I noticed a rotifer that at once struck me as different from any that I had before observed or seen described. On examination it proved to be a *Brachionus*, and a diligent search through the somewhat scattered literature on the subject has failed to indicate that this form has ever been described.

The Micrographic Dictionary follows the classification of Ehrenberg, while Carpenter, in his work, "The Microscope and its Revelations," adopts that of Dujardin. While all classifications of the rotatoria thus far made are more or less unsatisfactory, that of Ehrenberg seems the least faulty. According to the last named author, I find that this organism, by reason of having its rotatory disk divided into two parts (*Zygotrocha*) and having a carapace, would show that it belongs to the family "*Brachioneæa*." There are five genera in this family. The *Brachionus* has one eye-spot and a forked foot, and to this genus the rotifer unquestionably belongs.

Brachionus conium: Lorica, irregularly truncate, slightly reticulated over the entire surface except the collar, carrying frontal spines; this latter portion has a hard, vitreous appearance. There are ten frontal spines, the middle one on the dorsal surface is longer than the others, and describes almost a right-angled turn, near its centre, to one side. This spine is half as long as the carapace of the rotifer. Eye-spot prominent. No openings on the dorsal surface of the carapace. There are four posterior spines, one at either extreme side, and one either side of the anal opening. Tail or foot, slender and bifid. Extreme length of rotifer, including anterior and posterior spines, seven one-thousandths ($\frac{7}{1000}$) of an inch.

Unfortunately a dead specimen had to be used for the drawing; hence, no definite description can be given of the mouth-parts. The external appearance is, however, so strikingly characteristic as to serve all purposes of identification until the internal structure can be fully described.

I am indebted to Mr. W. M. Rebasz for the very accurate and well-executed drawings of this rotifer.

———o———

The Epidermal Organs of Plants.

BY CHARLES F. COX, F.R.M.S.

It is, of course, well known that those parts of plants which are exposed to external influences—to light, heat, evaporation, etc.—become compacted and hardened into a rather dense and rigid tissue called the epidermis. This differentiation is not well marked in roots and submerged parts of aquatic plants, but even in such parts we recognize at least a theoretical difference between the most exterior layers of cells and those of the so-called parenchyma lying beneath.

Upon the aerial portions of plants there is generally a tissue external to the epidermis—of the nature of a very thin, usually homogeneous and transparent pellicle or skin,—termed the cuticle.

The epidermis, however, may be regarded, physiologically, as the most external organized and organ-producing substance of the plant.

From this epidermis are developed all external appendages, known as hairs, villi, papillæ, tentacles, bristles, thorns, scales and glands, with analogous and homologous organs, including probably the sporangia of ferns, and even the ovules of phanerogams.

It has been proposed to class all such lateral growths from the epidermis under a single name: Trichomes. This grouping, however, not being entirely satisfactory in all respects, is merely tentative; and there is good reason to think that, when microscopical botany has been thoroughly worked up, the whole theory of the epidermis and its appendages will have to be reconsidered and much modified.

Hairs are the most attractive of the epidermal appendages, and are exceedingly varied in form, as well as often charmingly beautiful in appearance. They have long been favorite objects of observation with microscopists, though I cannot say that they have long been objects of scientific study and investigation; for, as far as I am aware, they have seldom attracted attention except for their external symmetry and beauty.

This mere prettiness of plant-hairs cannot be adequately expressed in description; and, so far from wondering that it has attracted attention, I am surprised that it has not attracted more; for I am sure that no class of microscopic objects offers more various beauties of outline, ornamentation and color, than do these exquisite gems of the vegetable world.

The outlines of different kinds of plant-hairs have often been figured, and I will not consume time and space in any attempts at an extended description here. It may be well, however, to mention the more characteristic forms.

To begin with, we have what may be called the right hair, which is a simple, perpendicular, or more or less appressed, unicellular growth, such as may be found on *Lithospermum hirtum* or *Lithospermum canescens.*

Jointed hairs are similar in outline to the right hairs; but instead of being unicellular, they are composed of a series of cells or nodes. Such hairs are found upon many of the Compositæ,—for instance, *Pluchea bifrons.*

In segmented hairs the component cells are separated by deeper constrictions than in jointed hairs; and they resemble, when filled with their living fluids, strings of translucent beads. Such hairs grow upon the stamens of *Tradescantia Virginica* and upon the leaves of *Polemonium cœruleum.*

Cleft hairs resemble right hairs which have been split part way down, and the separated portions of which have become more or less depressed. In some cases this depression proceeds so far that the hair appears to be a long, doubly terminated, horizontal cell attached to the leaf by a pedicel at its centre. Such hairs

may be seen on the leaves of *Clematis erecta*, *Astragalus vesicarens*, and of *Benthamia fragifera*.

Branched hairs are multicellular hairs in which growth takes place in many directions, or not entirely in one general direction. Examples of this mode of growth are found upon *Alternanthera lanuginosa*, and upon *Verbascum thapsus* and many others of the Scrophulariacæ.

A variety of this species is the radiate, in which the branching is confined to nearly horizontal planes. This form of hair occurs upon the upper side of the leaf of *Shepherdia Canadensis*, and upon many of the Polypodiaceæ.

These branching modes of growth (especially the radiate) give rise to many of the forms commonly included under the term *stellate ;* but I prefer to reserve that name for unicellular, star-shaped hairs, such as are found upon *Deutzia*, *Vesicaria* and some species of *Alyssum*.

Peltate hairs are those partly membranous, partly radiate, scale-like hairs, which occur upon all the *Elæagnaceæ*, upon some of the *Crotons* and upon *Sida lepidota*.

I apply the term rosette to those less scale-like, though nearly peltate, hairs such as are found upon *Croton caramba*. These differ from the peltate hairs in having fewer lines of radiating growth, and in being less membranous or scale-like. They approach closely to the forms of the glands of *Callicarpa*, of *Carya*, or of the Myricaceæ.

When several simple hairs are developed from adjacent epidermal cells, I term them grouped. Sometimes these grouped hairs consist of but two simple hairs in contact at their bases, but often five or six or more form a group which, when seen from above, give the appearance of a stellate form. Such stellately grouped hairs are common among the Malvaceæ and the Cistaceæ. In *Helianthemum canum*, var. *genuina*, we have a good example of stellately grouped, short hairs, associated with simple groups of two, three or four long right hairs.

Closely allied to this form is the one which I call mammillate. In this species what would be the central hair of a group is fully developed, but the surrounding epidermal cells are only partly developed into hairs, most frequently just enough to slightly raise them above the general surface of the epidermis, thus producing a protuberance or mamma upon the surface of the leaf, from the centre of which the fully developed, simple hair seems to spring. This is a characteristic form amongst the *Borraginaceæ*, and is most strikingly exhibited on the leaf of *Onosmodium Virginianum*. In some species, however, all the hairs are aborted, and what might otherwise be a group of hairs, is only a group of partly developed epidermal cells. This is exemplified in *Echinacea angustifolia*. On the other hand, it happens in some species that all the grouped epidermal-cells, or a large number of them, become fully developed hairs, but only the central one grows perperpendicular to the surface of the leaf, the others radiating about its base in a nearly horizontal position, or at an acute angle to the surface. A fine example of this is seen in *Onosma montana*.

Among the Compositæ a very striking, but not a very common, form of hair is what may be called serrate. In its simpler variety its outline somewhat resembles that of wool ; but in its more pronounced phase it suggests the hair of some animal among the rodents, particularly of the Indian bat. This is the case with the leaf-hairs of *Hieracium tomentosum* and of *Adenostyles lanatus*.

Glandular hairs (hairs bearing glands at their extremities) are found upon a large number of plants, particularly upon the so-called "insectivorous" plants, and also upon many others which possess glands rather for the purpose of secreting or ex-

creting than for absorbing, such as the tomato and *Rhodora*.

Tentacular hairs are the most differentiated and specialized of all,—they being endowed with the power of movement in response to stimulation, besides the power of secreting and absorbing. These are best exemplified in the Droseraceæ.

At the other extreme of the scale of development are what I term papillæ, which, together with what may be called villi, are perhaps not so much of the nature of immature or undeveloped hairs, as of organs intermediate between hairs and stomata. Instances of the occurrence of these forms—which are hard to separate, the latter being apparently only less differentiated than the former—may be found on many of the *Ericaceæ*, particularly on *Rhodora Canadensis* and *Rhododendron Nuttallii*, and also on *Clematis recta* and on *Porsooni salicina*.

There are, of course, many other forms of hairs, some of them intermediate varieties to those I have named, and some of them connecting links between hairs and glands or other epidermal organs; and several of these often occur upon the same plant or part of the plant.

It would be an easy matter to arrange a series of specimens showing an almost imperceptible running of one of these forms into another, in perfect gradation all the way from the true sunken gland up to the most developed and specialized forms of radiate, stellate, peltate or tentacular hairs.

The difference between a secreting, glandular hair and a true gland seems to consist mainly in the fact that one is entirely sessile, or sunken, while the other is more or less pedicellate. Sachs states that all reservoirs of oil, resin, gum, etc., whether internal or external, are only slightly different developments of the same organ; but if we include among such reservoirs the turpentine-cells of the Coniferæ, as has been suggested by some writers, we shall have to rearrange somewhat our present ideas of what are epidermal organs.

As may have been inferred from what I have already said, the forms of hairs, glands, etc., are more or less characteristic of families, orders, genera, and in some cases of species even.

This is the most interesting, and scientifically the most important point in this whole subject; but it has not yet been even approximately elaborated, and there is vast room for research here and great promise of valuable results.

Take the forms of hairs peculiar to the Elæagnaceæ, for example, they are as characteristic of the order as any other part of the plant; indeed, in this particular case, I think they are the most characteristic and distinguishing part. And yet little or nothing is made of these microscopical characteristics in classification, although enough has already been learned concerning them to show that they are more intimately connected with the physiological nature and natural affinities of the plant than are many less intrinsic qualities or characters, which are given a prominent place in the usual system of classification. To be sure, reference is sometimes made to the "silvery" appearance of some species, and to the "scurfy" appearance of others, to the naked eye, but the characteristic feature of *Shepherdia* or *Elæagnus* or *Hippophæ* is seldom even referred to in such botanical works as I have happened to consult.

The hairs of the *Malvaceæ* also are very characteristic. In general, to the casual observer, they seem to come under the very inclusive designation of stellate. But they are not stellate, in the proper limitation of that term, or as the hairs of *Deutzia*, for example, are stellate. In the genus *Sida*, and in one or two other genera, they are what I have called peltate, and in still other genera they tend toward what I have called the

radiate form. But throughout the larger part of the order they are what I have termed grouped hairs. Upon the upper side of the leaf they may be grouped only in twos or threes, or the hairs may be even solitary; but upon the under side of the leaf, or upon the calyx, the groups will probably consist of four, five, six or more hairs, disposed in such a way as to give rise to the so-called stellate appearance, although this stellate grouping will often be associated with the simpler aggregations, or with the single right hairs. But a tendency to stellate grouping, in some part of the plant or at some stage of its existence, is decidedly characteristic of the Mallow family as a whole.

In the genus *Althœa* there is a disposition to complexity of form and luxuriance of growth on every part of the plant—even on the petals.

In *Malva* there is less complexity of form and less luxuriousness of growth, the stellate groups being most pronounced upon the calyx.

In *Abutilon* there is still less hairiness and still less tendency to stellate grouping.

In the genus *Hibiscus* the hairs almost disappear from the leaves (especially from the adult ones), though the stellate groups still form rather abundantly upon the calyx and the seed-pod.

These facts are sometimes vaguely referred to in the text-books under the heading of pubescence; but usually *Hibiscus* is spoken of as smooth or glabrous, because the leaf in its adult stage is hairless, or nearly so, to the unaided senses, while the truth is that hairiness in some part of the plant, in some stage of its existence, and, as a general rule, hairiness of a particular kind, is almost if not quite as much a characteristic of this genus, as well as of its order, as are its "alternate, stipulate leaves and regular flowers, with monadelphous stamens."

Nothing can be more characteristic of the Borraginaceæ, as an order, than their hairinesss as seen under the microscope. This is generally of the kind I have described as mammilate; and so striking is this in almost every genus and species I have examined, that the minutest fragment of a leaf large enough to hold a hair, would in most cases be enough to determine at least the order to which it belonged.

Amongst the Cruciferæ, too, there are some very distinct groups of genera marked off by the peculiarities of their leaf-hairs, so that one who has once become familiar with *Alyssum*, *Vesicaria*, *Draba* and *Arabis*, for instance, would have little difficulty in determining the place of a specimen of one of them, by microscopical examination alone. As far as my experience has gone, the grouping of plants by their microscopical characteristics has been found to accord in the main with the classifications already made by botanical science on other grounds; but in running through the order Cruciferæ, for example, one is often struck by the wide dissimilarity discoverable by the microscope, between certain groups of genera; and one is led to wonder whether plants so different in their minute structures can really be near relatives, even though their mode of inflorescence and some other attributes may be similar.

Nevertheless, the microscopical characteristics of plants may be determined and tabulated so as to be of much value for purposes of identification; and I am inclined to think that such labor will some day result in a system by which either extant or extinct orders, at least, can be identified to a certainty; and such a system would be of no little importance in many lines of scientific investigation, as will at once be seen. Thus, in geological science, buried parts of plants would throw light upon the age and character of the deposits in which they were found, and in zoological science even the half-digested food of beasts, birds or in-

sects might be made to disclose the habits of the eaters.

But, as has already been foreshadowed, it is not only the mere form or figure of the hairs that is characteristic. Their distribution upon different parts of the plants is also a matter of regular and peculiar habit, as well as their existence or non-existence at different stages of the plant's history.

In many plants the young leaves or stems are hairy or scaly, while the adult parts are quite smooth.

We recall the fact that the *ramenta* of ferns commonly fall off when the frond is fully developed; and this is also true of the hairs of many phanerogams. But even when the hairs are not shed, the adult leaf will be relatively much less hairy than the young leaf, from the fact that the hairs are developed coincidently with the leaf itself, and that their number does not increase as the leaf increases in size. The same number of hairs is, therefore, spread over a much greater surface in the adult leaf than in the young, growing leaf; and the young leaf is therefore the more pubescent, relatively to its surface. This has an important bearing, as will be observed when I come to speak of the physiological side of my subject. It follows from the fact I have just mentioned, that to obtain the most striking specimens of vegetable hairs, the microscopist generally selects the young, terminal or rapidly growing leaves, stems or petioles.

Another point as to distribution, I have barely referred to already, and that is that even when leaves are entirely hairless the calyx may be hairy. Sometimes this is true of the petals, and often of the filaments. In other words (to generalize these facts), hairiness begins at the growing point, and persists there the longest. It may never exist elsewhere on the plant to any considerable extent, but it is likely to exist upon the part last developed, whether leaf or flower. The hairs may drop off from the older parts, but they are not often absent from the younger parts. This matter also has an important connection with physiological facts, which I shall mention hereafter.

One of the most obvious facts connected with the distribution of hairs is that they are found more frequently and more abundantly upon the under side than upon the upper side of the leaves, the sepals or the petals. This is a very general rule, though there are exceptions to it which seem to indicate that the relative hairiness of the two surfaces of the leaf depends upon the position in which the leaf grows. I am inclined to the opinion that when the leaf naturally assumes such a position that one side receives a much larger amount of light than the other, that side will be the least hairy, if not entirely destitute of hairs, while the shaded side will be the one most favorable to hairiness. In plants whose leaves grow more or less perpendicularly, the difference between the two sides is apt to be less marked.

Heliotropism may affect the relative hairiness of the two sides of the leaf, either in causing a greater difference by presenting one side more constantly to to the light, or in causing less difference by presenting both sides equally. It is said that the "compass plant" of our western prairies (*Silphium laciniatum*), always presents its leaf in a plane with the north and south meridian, and both sides of its leaf are alike; but, aside from its heliotropism, this may perhaps be due merely to the leaf's tending to a perpendicular position.

In the Bayberry (*Myrica cerifera*) we find that the upper side of the leaf is the more hairy, while the glands follow the general rule in being more abundant on the under side. But, notwithstanding these occasional exceptions (which will doubtless be found to be explainable in accordance with the general theory), it is a rule that the under side of the leaf, and that which corresponds to

the under side in homologous parts, is the hairy side. If both sides are hairy this side will be the more so. This, as I have already said, I am inclined to refer to the influence of light as a general principle, though the fact that the hairiness of sepals and petals is still on the outer side (or the side corresponding to the lower side of the leaf), does not seem to be directly explainable on this theory, but seems to be indirectly connected with it, through the mere homology of the parts.

Another very obvious fact as to distribution, is that hairs are most abundant upon the mid-rib and the larger fibro-vascular veins. When they do not exist at all upon other parts, they are often abundant upon these vessels, and the mid-rib is seldom absolutely hairless. It is one of the most striking points in connection with this subject, that hairs commonly spring from the surfaces of fibro-vascular bundles, or are more or less directly connected with them. In most plants this characteristic is plainly seen, but in many it is obscured by the great profusion of hairs; and in some, though not hidden, it is not marked. I believe, however, that there is an essential relation between hairs and the fibro-vascular system, which I will refer to more specifically by and by.

What I have said as to the distribution of hairs, is generally true also of glands. Indeed. this is to be expected from the fact that hairs and glands are only different developments of the same organ, as it has been already stated.

Glands exist under every form, from a mere epidermal cavity containing an essential oil, as in *Magnolia glauca* (the White Bay), or *Hypericum parviflorum*, to the complexly specialized, secreting and absorbing tentacles of the Droseraceæ. Between these extremes we find a mere orifice emitting a drop of resin or gum—as in *Gaylussacia*—the half-external, half-internal, multicellular, rosette-like gland of *Rhododendron ferrugineum*, the sessile, but quite external gland of *Myrica* or *Callicarpa*, the glass funnel of *Chenopodium*, the pedicellate, spreading, flower-like gland of *Rhododendron Nuttallii;* the short, glandular hair of the tomato or *Rhodora* or of *Pluchea;* and the long, stinging hair of *Urtica*. As has been intimated already, the hairs of *Croton caramba* and the glands of *Carya glabra* are so nearly alike in appearance that they may be regarded as connecting links.

One of the characteristics of all epidermal appendages is the tendency to a deposition in them of silica or of lime, particularly of silica. In the Diatomaceæ the siliceous frustule is the largest part of the whole organism.; and in the Equisetaceæ and the Gramineæ the deposit of silica in the epidermis and cuticle is of no small amount or importance. The peculiar form of the deposit in and upon many kinds of hairs is a distinguishing mark, and in many it is so general and abundant that an indestructible cast of the hair remains with the cuticle, after maceration or burning of the leaf on which it is found.

This is particularly the case with the large and striking stellate hairs of the Deutzias. In these hairs as well as in many others (as for example: those of *Onosmodium*, *Lithospermum*, *Benthamia* and *Astragalus*), the silica is disposed in apparently granular masses, distributed over the surface of the hair, giving it the appearance of the larger and coarser spicules of some of the Gorgonidæ.

Under a high power these grains have sometimes seemed to me more like irregular truncate cones, or like the deposits of silica or lime which form on a larger scale around the mouths of geysers and hot springs, and I have therefore imagined that perhaps they were actually formations about orifices from the interior of the hairs, though I have never been able to demonstrate, to my own satisfaction, any such opening through them.

Before passing to another division of my subject, I must say a few words about stomata, which also are epidermal structures. As a general rule they are found upon the same parts as the hairs and glands, and in the same relative proportions. That is to say, they abound upon leaves and homologous parts, and on young and growing stems and branches; and they are found in most abundance on the under side of leaves. Unlike hairs, however, they never appear upon the mid-rib and veins, but are always found directly over intercellular spaces, of which they are the means of communication with the external air. Of course they are useless, and therefore exist but as stragglers, if at all, on parts not exposed to the air. They are therefore not usually found on true roots or submerged parts of aquatic plants. Like hairs, their relative number upon the upper and upon the lower side of the leaf depends in great measure upon the natural position of the leaf with reference to the light.

(*To be continued.*)

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Sidle's New Mechanical Stage.

In the April number of this JOURNAL was a notice of our mechanical stage. This having occasioned a host of inquiries, we now publish, for the first time, a short description of it.

The general plan of our new mechanical stage is similar to that lately introduced by Mr. R. B. Tolles, of Boston. The stage has rectangular motions of one inch, actuated by rack and pinion movements of great smoothness. The milled pinion-heads are on the upper surface of the stage, and, both being on the same axis, are readily accessible in any position of stage without changing the position of the hand. The stage allows of an entire rotation—the pinion-heads being always within its circumference. The entire thickness of the stage, from top to the bottom of the outer ring, approximates .25 inch. Notwithstanding this extreme thinness, we have, by the use of hard rolled German silver and brass, succeeded in making it perfectly firm. It might be still further reduced, but we have decided, after mature consideration, that the interchangeable feature, spoken of further on, combined with a good, stiff stage, free from spring, affords more practical advantages than would any further reduction in thickness.

The mechanical, together with the plain stage, accompanies our "Acme" No 2 stands. The two stages are interchangeable by a simple spring-clip arrangement which permits of the instant exchange, and insures smooth motion in rotation. The ring, or bed-plate, in which these stages rest, is provided with centering screws and is finely graduated.

This stage, with ring or bed-plate, can readily be adapted to any stand that will admit of a stage five inches in diameter.

J. W. SIDLE & Co.
LANCASTER, Pa.

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The Study of Infusoria.*

BY DR. S. O. GLEASON.

Infusoria are microscopic creatures, very minute, of almost endless variety, found in infusions of animal or vegetable matter. In their adult or complete form they are furnished with prehensile or locomotive appendages, in the form of cilia, flagella and tentaculæ. They are unicellular, free or sedentary, live in a mucilaginous matrix, single, or united in colonies. Food is incepted into a distinct oral aperture, through a limited terminal region, or through the entire surface of the body. They increase by longitudinal or transverse fission, and by external or internal gemmation, preceded by a quiescent or encysted state, resulting in a greater or less number of sporular bodies.

* Abstract of an article read before the Elmira Microscopical Society, February 24th.

The infusorial world, with its countless number of inhabitants—more numerous than the stars, or the sands of the seas, surround us upon all sides! They abound in the river, creek, pool, pond and the open sea. Every blade of grass, every flower, the atmosphere we breathe, the food we eat, swarm with them. There is no limit to the diffusion of life where air and moisture exists, fascinating alike the biologist and the young explorer in the study of their forms and habits. Particularly is this the case since the great improvements that have taken place in our optical instruments, during the last ten years, by means of which the most minute, elementary and beautiful forms of life have been studied.

Siebold, in 1805, expressed an opinion that animalcules consisted of simple cells or vesicles, forming protoplasmic masses, from which all higher organisms were evolved, and that in turn, the higher passed into the lower forms. Tracing these minute creatures through their various changes, brings us to the dim, shadowy line (too subtle, too obscure for positive definition) that separates or blends all animal and vegetable life together.

A brief history of the more important epochs of infusorial investigation might be arranged somewhat as follows: The original inventer of the microscope, or the double convex lenses used as such, cannot be positively identified. These investigations commenced over two hundred years ago, and we are surprised at the results obtained by those early investigators, with the rude appliances with which they worked. Out of the use of these simple lenses, through long and tedious processes, was evolved the compound microscope. Fontana, of Naples, Drebell, of Germany, and Jansen & Son, of England, have in turn been credited with the invention, which, in its simplest form, attracted public notice about the year 1619. Nearly half a century passed before it was regarded as more than a toy, until Petrus Borellus, an Italian, made some discoveries among the lower forms of animated life. Then came an Englishman, Dr. Robert Hooke, who, in 1665, wrote his famous "Micrographia Illustrata." A few years later the illustrious Dutchman, Antony Van Leeuwenhoek, made extensive scientific researches in this field, and stimulated others to take up the study. His earliest contributions are found in "Philosophical Transactions" for the year 1677. [Examples of this eminent investigator's descriptions of the curious infusoria he had met with were given, the quaint expressions causing much merriment.] Further investigations were made by some Englishmen in 1703, confirmatory of what Leeuwenhoek had discovered with his simple apparatus, twenty-five years before. Next, the names of Sir E. King, John Harris and Stephen Gray are recorded as those of able contributors and investigators in this respect.

The very first illustrations of infusoria are found in a publication of Sir E. King. John Harris gave the first description of *Euglena viridis*, and he made some very shrewd observations on their rapid mode of reproduction.

The Doctor next touched upon the very crude, but ingenious contrivances that early investigators used in making their remarkable discoveries. In 1703 several of the larger species of infusoria were accurately described and figured by Leeuwenhoek, Wilson and others, Wilson claiming to have constructed a lens that magnified 640 diameters. In the earlier half of the eighteenth century contributions to infusorial history were made by Louis Joblot, Henry Baker and Abram Trembly. Joblot, in 1718, published a treatise on "Microscopes and Infusoria," in which his imagination played havoc with existing facts. Henry Baker, in 1742, wrote a book, entitled "Microscope Made Easy," which contributed to the stock

of knowledge of infusoria. Trembly described the *Hydra* and *Stentor* with great accuracy, about this time. In 1786 Otto Frederick Muller published a work with no less than fifty plates and 367 pages of letter-press, devoted to descriptions of about 300 species.

Gluchen was the first to demonstrate that infusoria assimilated finely triturated carmine. Spallanzani demonstrated the "pulsating vesicle." Up to 1830 all infusoria were classed in two orders; one embracing the rotifers, and the other, the apparently structureless and homogeneous animalcules. In 1838 Ehrenberg published his great work, "History of Infusoria," which surprised the whole scientific world. This treatise contained 532 pages, with an atlas of 64 colored plates of several hundred species. This work to-day remains one of the recognized authorities, and challenges our admiration for the wonderful results obtained by this indefatigable worker, with the imperfect instruments used in his investigations.

In 1841 Dujardin published his celebrated work which gave entirely new views of the organization of many groups of infusoria, and corrected some mistakes made by Ehrenberg. He discovered that the Foraminifera possess no distinct organs, that they have a simple gelatinous body, capable of extending fine, thread-like prolongations in every direction, by means of which they adhere to and creep over objects in the water. He described and named the *Diffulgia* and the naked *amœba*, and from their putting forth root-like extensions for locomotive purposes, gave the name of Rhizopoda to this class of creatures. He entered into an investigation of their anatomy, and named the body-substance sarcode. He denied that they had any nervous, muscular or complex digestive system, as taught by Ehrenberg. He found that food was not retained in any permanent stomach-sacs, but passed into the sarcode-mass to be expelled anywhere after the nutritive portions had been absorbed.

In 1845 Carl Theodore von Siebold came to the front, asserting the unicellular nature of infusoria. He established the sub-kingdom Protozoa, and divided it into Rhizopoda and Infusoria.

In 1860–61 Max Schultze developed and modified the theories of Siebold. He claimed that in many cases there was no distinct cell-wall, but that the cell was made up of a multiplicity of cells without walls, indistinctly amalgamated with each other. He gave the name protoplasm to the cell that seemed to have no cell-wall. He originated the idea that the cell-contents of all animal and vegetable organisms are made up of a similar protoplasmic basis that is typified in the amœba, as a mere speck of animated, undifferentiated protoplasm.

In 1861 Andrew Pritchard compiled his work, but gave us nothing essentially new. In 1868 Prof. H. James Clark, of this country, discovered a new type of flagellate infusoria, and announced that all sponges consisted of a colonial family of flagellate animalcules. In 1873–75 Dallinger and Drysdale made some splendid investigations with the improved microscopes then in use. The work principally resulted in the discovery of the rapid manner in which flagellate organisms multiplied, and that like forms beget like. In 1876–77 John Tyndall made some important investigations upon the organisms found in impure air and in putrefying substances, showing the vital persistence of putrefactive and infective organisms. This brings the history of infusoria down to the present time.

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Oleomargarine and Butter.

At a meeting of the New York Microscopical Society, on May 6th, the President spoke substantially as follows :—

The first patent for the manufac-

ture of oleomargarine was issued in this country in the year of 1873. Since that time a number of other patents have been taken out, but none of them have as yet assumed any considerable importance. Paraf obtained a patent in April, 1873, for the manufacture of what he termed "oleomargarine," and in December of the same year the celebrated Mége patent was issued. The butter manufactured under Paraf's patent possessed a distinctly crystalline character. The Mége butter, however, is smooth and palatable. The process of manufacturing artificial butter may be briefly described as follows: Caul fat, thoroughly washed, is reduced to a pulpy condition, and the fatty matter separated from the adipose tissue by melting at a temperature not higher than 125° F. This low temperature is essential to the success of the process, for it is impossible to obtain a perfectly bland, sweet oil at a higher temperature. After settling and skimming, the oil is drawn off and permitted to solidify. It is then packed in cloths and subjected to gradually increasing pressure, at a temperature of 80°–90° F., until all the oil is pressed out, leaving cakes of pure, white stearine in the press. When the oil attains a temperature of 70° F. it is churned with sour milk and then drawn out of the churn into tubs containing pounded ice, where it immediately solidifies. After separating it from the ice it is finely crumbled by hand, and again churned in sour milk, after which it is worked, salted, and packed for sale.

The manufacture of artificial butter in this country has become a very important industry. During the year ending June, 1880, there were exported from the United States 19,833,330 pounds of oleomargarine, valued at $2,581,317.

As to its relations to true butter, it need only be said that many persons cannot distinguish it from the latter. However, undoubtedly a good butter-taster could not be deceived.

It is my opinion that one can always detect the oleomargarine by the taste alone; but this is not said with any great degree of assurance. However, there can be no doubt that the better grades of oleomargarine are more palatable than common butter. On the score of healthfulness, oleomargarine can be confidently recommended. Chemically, it has almost the same composition as butter; it differs from butter mainly in having a much smaller percentage of certain fats peculiar to butter to which its characteristic odor and flavor are due. The object of the second churning is to introduce some of these into the product. It contains also more casein than butter. Owing to the absence of the fats above referred to, the artificial butter is not likely to become rancid.

As the subject of adulteration has lately been before the Society, a brief notice of the adulterations to which butter is subjected may be of interterest. It has been asserted that lard is added to butter in the West; but no authoritative information upon that subject has yet come to my notice. Oleomargarine butter is mixed with the natural product by the farmers, at least it is so stated by persons who are probably well-informed upon the subject; and this adulteration would be very difficult to detect unless the microscope would reveal it, and it undoubtedly would in some cases. An excess of salt in butter constitutes an adulteration; for not only does the salt injure the butter for consumption, but it also enables the maker to incorporate a large amount of water with the butter,—even as much as 40 per cent. of water has been found in butter, held by the excess of salt.

The microscopical examination of butter and oleomargarine must be conducted with extreme care, for it is very easy to draw erroneous conclusions. Nevertheless, I am inclined to believe that the microscope will, when properly used, enable us

to distinguish one from the other. What may be regarded as the perfect oleomargarine, does not contain crystals. The controversy between Mr. J. Michels and Dr. H. A. Mott is still fresh in our memories, and can hardly be regarded as very creditable to either side. I have no doubt that Mr. Michels did see just such things as are depicted in the *Times* of June 27th, 1878 (Fig. 6), and Dr. Mott's very unprofessional criticisms were quite uncalled for. The fact is, as I hope to show you this evening, that some specimens of oleomargarine do contain bundles of distinct crystals, while others do not. As regards the impurities which have been stated to occur in artificial butter, such as muscular tissue and animal matter of various kinds, I have never been able to identify a single shred of muscle in any of my examinations. However, a certain amount of debris, which very likely comes from the fat-cells—the adipose tissue—does occur in the artificial product, but these can hardly be regarded as a distinctive characteristic of the product. In the absence of distinct crystals, a person who is familiar with the appearance of both butter and oleomargarine under the microscope, would probably be able to distinguish one from the other by the general appearance of the field, but not from any characteristics that can be definitely described. The artificial product possesses a certain grain, especially when examined with a power of 1,000 diameters or more, which is not resolved into a minutely, crystalline structure, but which, nevertheless, shows some indications of a crystalline arrangement of the particles. Such an appearance is not to be observed in butter.

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Ivory Drop-Black.

The above is a material which I have been using for more than eighteen months as a background for all of my opaque mounts. With the exception of a few persons in this city to whom I have communicated my method, I do not know of its having been used for this purpose ; and it makes, when properly applied, a beautiful, smooth surface. I have tried various kinds of drop black, but now I use only the "XXX ivory drop-black" of Sherwin, Williams & Co., of Cleveland, O.

This is put up in collapsible tubes, selling ordinarily at twenty-five cents ; I am told that it is ground in japan, and not in oil. It gives the finest ground of any black color I have been able to procure. Drop-black ground in oil will not do, as it always dries with more or less gloss.

The following is my method of using it. Press a small quantity of the color into a one-ounce, wide-mouth bottle, and thin it sufficiently with fresh turpentine ; it may be made quite thin.

The slide being on the turn-table, whirl the latter and apply the color with a brush. If the color is too thick, it will be found that it cannot be smoothly spread, and that it will dry in ridges. If too thin it will be found necessary to make several applications. If it is necessary, a second application can be made within fifteen or twenty minutes.

I generally use curtain rings for my opaque mounts, and these rings are afterwards attached to the slides by means of Brunswick black or marine glue.

I would advise all who try this process to get the very best color, and to be sure it has not been ground in oil, and also in thinning it to use only fresh turpentine, as the older the turpentine is, the more likely will it be to dry with a greasy appearance. The ring being attached, I freely apply the Brunswick black around the edges inside. This being dry I apply white color on the same edges, which assists in the illumination. When dry the cell is ready for the object.

ED. GRAHN.

How to Imbed in Paraffine.

While I have often seen paraffine recommended as an imbedding material, the manner of using it I have never seen published. I therefore offer the following method of my own to the readers of the JOURNAL.

Make a short paper tube the same size as the well-hole of the section cutter, by rolling a strip of paper around a cylinder; fit a cork to one end of the tube and attach to the upper side of the cork, by cement or otherwise, the specimen you wish to cut (previously hardened in alcohol, if necessary), in such a manner that it will stand upright in the centre of the tube; now fill the tube with melted paraffine; when cold remove the paper, and you have a plug of paraffine enclosing the specimen. I usually make several of these plugs at a time, and keep them in alcohol until wanted.

I have only used paraffine in this way for cutting vegetable sections, but I see no reason why it is not equally well-adapted for any other soft substance.

E. L. CHEESEMAN.

KNOWLESVILLE, N. Y.

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Cleaning Diatoms.

The following process is the result of a recent fortuitous experiment. Let us suppose that we have succeeded in bringing a quantity of diatomaceous material to the state of a beautiful white powder, as previously described, by the use of the bi-sulphate of potassa, or the more easily procured substitute suggested. We then proceed as follows: Procure a piece of silk about four inches square, of good quality and of very close texture; moisten it thoroughly at first, and, in its depressed centre, place a small portion of the fused material to be cleaned; then add to it several drops of water to bring it in solution, collect the sides and corners of the silk together, twist them to prevent the escape of material or fluid, compress immediately above the material, and carry the pressure down gradually, without, however, bringing the pressure of the fingers to the bottom part of the silk; this compression forces out the water, and with the water a large percentage of the undesirable impurities contained in the material, while the close texture of the silk holds back the various diatoms and discs, with the larger particles of sand. After the first compression a few more drops of water are added and the pressure renewed as before. The silk is then turned inside out, and washed by gentle shaking in a deep watch-glass to remove the diatoms, etc. We now note an absence of milkiness in the product, and the cleaned residue remains at the bottom of the crystal; by transferring this to a deeper receptacle, we can then dip up the diatoms with a pipette to mount direct on slide or cover-glass. This method gives surprisingly fine results.

A knowledge of the two methods of operating on diatomaceous material, as communicated by me, will enable the possessor of a suitable microscope to launch into the preparation of diatoms for study, with success at the outset.

K. M. CUNNINGHAM.

EDITORIAL.

—The first part of the "Catalogue of the Diatomaceæ" is partly printed, and will probably be completed this month or in July. The fourth part of Kent's "Manual of the Infusoria" has been issued. The third fasicle of Van Heurck's "Synopsis of Diatoms," which has been unexpectedly delayed, is expected this month.

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A SCIENTIFIC EXHIBITION.—On the 17th of August the American Association for the Advancement of Science will meet in Cincinnati. On the 8th of September the Annual Cincinnati Exposition will open, to continue a month. At the Association meeting

there is to be a large exhibition of scientific apparatus and collections, which will be continued over through the Exposition, to compete for a special premium list. The Exposition Commissioners this year offer medals and awards for chemicals, chemical and physical apparatus, microscopes, engineering instruments, and various objects in natural history. For the best display of microscopes and accessories a gold medal is offered; and for the best set of slides, not less than fifty in number, a silver medal. Certificates of superior merit will also be awarded for the best microscope-stand, the best object-glass, and the best polarizing apparatus. As there will, undoubtedly, be a very large attendance at the meetings of the Association, it will be for the interest of manufacturers and dealers in microscopes to show their instruments. Some makers have already signified their intention to exhibit, and there is every prospect of a brilliant and novel exposition. The display during the Association meeting is to be in charge of the Department of Science and Arts, of the Ohio Mechanic's Institute. F. W. C.

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A Prize for Microscopical Work.—Dr. E. P. Murdock, the Curator of Rush Medical College, of Chicago, has informed us that in order to stimulate more interest in the study, and greater efficiency in the practical work of microscopy, Mr. W. H. Bulloch, of Chicago, has offered an annual prize of $50 for five years, in the form of a microscope stand, to the student from any chartered college in Chicago, who passes the best examination in the theory and practice of microscopy, at the time of his graduation. The prize is to be awarded on competitive examination, conducted by a committee of competent microscopists.

The following gentlemen have consented to act as the examining committee: Prof. I. N. Danforth, Rush Medical College; Prof. Charles Adams, Chicago Homœopathic College; Prof. Lester Curtis, Chicago Medical College; Prof. E. S. Bastin, Chicago University; Prof. E. B. Stuart, Cor. Sec. Ill. State Microscopical Society.

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Buffalo Microscopical Club.—We have received a pamphlet of twenty-seven pages, containing an account of the Annual Meeting of this Club, held last February. The report of the Secretary, Mr. Fell, shows that the fifth year of the organization has been one of success and prosperity. The Club has no stated admission-fee or dues, but the expenses are met by voluntary contributions from the members. There are thirty-two members. A number of important scientific articles have been read during the year. The address of the retiring President, Prof. D. S. Kellicott, is printed in full. It begins with some remarks and suggestions about the constitution, organization and work of microscopical societies, after which follows an interesting, historical account of microscopy in Buffalo.

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Animals or Plants.—In his valuable work, the "Manual of the Infusoria," Mr. Saville Kent has placed the so-called Myxomycetes in the animal kingdom. These peculiar organisms, in one stage of their existence, consist of an apparently structureless mass of living jelly, which spreads, by an amœboid motion, over the matrix upon which it grows. Such masses of contractile, living-matter are known under the general name, plasmodium. Long ago De Bary and Cienkowski maintained that the organisms in question were animals, but they have lately been almost universally regarded as fungi. Mr. M. C. Cooke, in *Grevillea*, has made a rather savage attack upon Mr. Kent's position, and in reply Mr. Kent has published an article entitled "The Myxomycetes or Mycetozoa; Animals or Plants?" in the *Popular Science Review*. We regard Mr.

Kent's arguments as well worthy of serious consideration, although they will hardly prove strong enough to induce mycologists to entirely change their views upon the subject.

Without attempting to fully discuss the subject in this place, we may inquire whether it must be, as seems to be universally assumed, that every simple organism that exists must necessarily belong to one or the other of the two great kingdoms, animal or vegetal. This we cannot believe, for the protoplasm, the so-termed "physical basis of life," which, so far as we can ascertain, is identical in the cells of both plants and animals, when unconfined by a cell-wall and free to manifest its characteristics, will certainly move about, collect food and grow. Is it therefore animal or vegetal? The theory, or hypothesis, of evolution requires us to assume a starting point for life, which we may find in a simple mass of protoplasm, from which both animals and plants have developed. Was the primordial germ distinctively an animal or a plant? Probably it was not—it was simply living matter; and as the biologist finds great difficulty in determining the true nature of many microscopic forms, since the two great kingdoms merge so imperceptibly together, the sub-kingdom Protista, of Häckel, seems to be not only a convenience, but a scientific necessity, although not including all the forms placed therein by its illustrious founder.

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PRIZE-OBJECTIVE.—It will be remembered that last year a prize-objective was given to Mr. C. M. Vorce, at the Detroit meeting of the American Society of Microscopists, for the best essay upon adulterations. This year another prize-objective, a one-half-inch, first-class, adjustable, made by Messrs. Bausch and Lomb, will be presented by Mr. Griffith, at the Columbus meeting. The objective is now ready, and we understand that it is a very excellent one.

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HANDWRITING.—Mr. C. M. Vorce has lately made some interesting observations in the examination of handwriting, which he has communicated to us. The signature to a note, which was claimed to be forged, was compared with a number of other signatures known to be genuine, and under the microscope they all appeared to be identical in every respect. Nevertheless, the writer of the other signatures, his wife, sister-in-law and son, all swore "to facts which, if true, rendered it impossible" that the signature upon the note could be his, and the jury decided that the latter was a forgery. A dozen or more experts swore that the signature in question was genuine. Mr. Vorce sums up the matter thus: Either the experts were all mistaken and one man committed perjury, or else five men committed perjury.

The case is an interesting one, for it indicates a possibility that a forgery may be so well executed as to defy detection. We are unwilling to admit such a possibility, however, without further evidence to prove it.

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DESMIDS NEW TO BRITAIN.—M. C. Cooke, LL.D., F. L. S., read a memoir before the Quekett Microscopical Club of London, in October last, which now appears in pamphlet form, with two pages of colored figures of desmids new to Britain. One form is new to science, *Staurastrum anatinum*.

The *St. arctiscon* is evidently the same as *St. munitum* of Wood, not uncommon in this country. *St. Pringsheimii*, we have as *St. hirsutum*, Ehr. *St. aversum* has not been recognized, but probably it has passed for a variety of *brevispina*, which is not rare. *St. megacanthum* has not yet been mentioned, but we have it repeatedly sketched in MS. from different localities. *St. ophiura* was added to our list last summer, from Split-rock Pond, N. J. With the exception of *St. grande* the

species are all known here. The memoir is a beautiful and a valuable contribution. F. W.

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FRESH-WATER ALGÆ. — Another valuable contribution, from the pen of Otto Nordstedt, of Sweden, gives a descriptive list of Algæ, mostly desmids, discovered in the examination of a collection of *Utricularia* in the Museum of the city of Leyden, Netherlands. The plants were mostly gathered on the island of Java, but some also in South Africa (Senegal), and others in South America (Venezuela).

It is interesting to notice the distribution of so many species over widely separated countries. One might suppose that lands so distant, and in tropical climates, would have a flora perfectly distinct from that of the United States. The list shows twenty-five forms, principally desmids, which have been indentified here. Only seven are new ; eleven are varieties or subspecies ; others have been described heretofore, but not usually as coming from the same countries.

The same paper describes the Characeæ of New Zealand, among them one new species. F. W.

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DR. LUDWIG RABENHORST.—Many will hear with deep regret the announcement of the death of Dr. Rabenhorst, of Saxony, at his residence near Meissen, on the 24th of April, after a lingering illness.

Dr. Rabenhorst has been one of the most earnest and enthusiastic workers in cryptogamic botany for nearly half a century. His first work of importance was his "Deutschlands Kryptogamen Flora," which appeared in 1847. Every year or two since he has made some valuable contribution to the literature of algæ and fungi. He was perhaps best known in the United States by his three volumes entitled "Flora Europæa Algarum," and by his "Algæ Exsiccatæ," a periodical issue of prepared specimens of fresh-water algæ. The latter "decades" contained many specimens from the vicinity of Bethlehem, Pa., collected by the Rev. Francis Wolle, one of our well-known contributors.

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THE DEVELOPMENT OF THE SQUID. —Already the Zoological Laboratory of the Johns Hopkins University, under the able direction of Prof. W. K. Brooks, has contributed much valuable information to various departments of natural history. Prof. Brooks has recently studied the development of the squid, *Loligo Pealii*, and his results are published in the "Anniversary Memoirs of the Boston Society of Natural History," illustrated by three large plates. The embryological development of the squid is essentially like that of *Sepia officinalis*, as described by Kölliker, and of an unknown decapod Cephalopod, as given by Grenacher ; but in minor points it is different from either of them. Professor Brooks has been very successful in tracing the development from a very early stage, soon after the blastoderm had begun to form.

The Cephalopoda are among the most highly specialized of the Invertebrata, hence, they must have passed through a long and complicated phylogenetic history. Nevertheless, the embryonic record, as shown by these researches, has been simplified to such a degree, that the ontogenetic processes afford no knowledge of the phylogeny of the group. They do, indeed, lead us to a clearer understanding of the homology between the organs of the Cephalopoda and those of a typical Mollusc, but they do not afford any basis for speculation as to the origin of the former, nor indicate how its peculiar specializations of structure have been brought about. The course of development is remarkably direct, the only rudimentary organs observed are the velum and the eye-stalks. Every-

thing that does not contribute directly to the formation of the adult animal has been dropped out of its life-history. The monograph referred to has been issued in pamphlet form, and is well worthy of careful study, being both interesting and instructive.

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CHROOLEPUS AND THE SCHWENDENER HYPOTHESIS. — The March number of the *Brebissonia* contains a short article from Prof. J. B. Schnetzler upon *Chroolepus aureum*, Ktz., one of the aerial algæ, which seems worthy the attention of those who are interested in the questions regarding the nature of lichens, that have reeently been so warmly discussed in the cryptogamic periodicals. We have scarcely space for the entire article, but we translate and condense parts of it as follows:

"Upon moist rocks, in the vicinity of Lausanne, small cushions are found, formed by an aerial alga (*Chroolepus aureum*, Ktz.). It is formed of ramifying filaments, the cells of which produce drops of a yellow-colored oil instead of starch. In the lichens belonging to the family Graphideæ, this alga is found associated with a fungus which, like a parasite, profits by the nourishment prepared by the alga.

"The alga which I have found presents an interesting fact. It is a perfectly independent alga. Upon the rami, globular, lateral sporanges are found; but at the base and upon the sides of the filaments one sees the hyphæ of a fungus in the form of colorless filaments, which apply themselves to the cells of the alga, and even penetrate them. These hyphæ form a plexus between the ramifications of the alga, and thus unite and entangle them.

"The fungus is therefore an intruder, which establishes itself upon an independent alga. Little by little it becomes master, and, thanks to the nourishment afforded by its host, the latter becomes completely enveloped."

CORRESPONDENCE.

TO THE EDITOR:—I found a rich pond yesterday, and, knowing your desire to publish localities of objects, I write you of it. The pond is on the south-east part of this city, and yesterday it was literally alive with *Chirocephalus diaphanus*. You will find them described in "Baird's British Entomostraca," and referred to there as rare. I do not know whether they are rare in this country or not, but this is my first view of them. I would like to send some to you, but they are very fragile and would not stand transportation—some died on my way home.

H. F. ATWOOD.

ROCHESTER, May 2d.

NOTES.

—Dr. R. U. Piper, of Chicago, who was in this city last month, urgently requested us to publish a letter from Mr. A. Montgomery, attorney in the case of Henderson *vs.* Wm. Lill's executors, to which reference was made by Dr. Lester Curtis in his article in Vol. I, p. 124, of this JOURNAL. It seems rather late to bring the subject again into notice; it may be stated, however, that the object of the letter is simply to prove that the testimony of Prof. Babcock, as given by Dr. Curtis, was not presented in court, and that Dr. Piper was the only microscope-expert examined for the defendants. Prof. Babcock's testimony related to the nature of the ink, not to the characteristics of the writing.

—Probably all who have had occasion to fix objects, such as diatoms, for example, upon a slide, by means of gum Arabic, have been more or less annoyed by the granular appearance of the gum. Mr. H. J. Waddington * obtains a solution of the pure gum, arabin, in this manner: Selected pieces of gum Arabic are dissolved in distilled water, so as to form a thin mucilage. This is filtered, and the filtrate poured into a considerable volume of alcohol, which precipitates the arabin. This is separated from the mother liquor by filtration, washed with alcohol and finally dried. It is freely soluble in water

* *Journal of the Quekett Club.*

and can be used, instead of the ordinary gum, with advantage.

—Mr. T. Charters White* has devised a growing slide which is cheap and seems to be quite useful. He builds up a cell by cementing strips of thick plate-glass to a slide, which may be of any size desired. Then within the cell a piece of the same plate-glass is cemented in the centre, leaving a space all around it. This space is partly filled with water, and the object to be studied is placed upon the central plate-glass and covered in the usual way. The water in the reservoir prevents the drying of the specimen by evaporation.

—A writer in *The Indiana Medical Reporter* recommends the following process for mounting starches. Half a grain of anilin blue is dissolved in an ounce of water and twenty-five drops of alcohol. Equal parts of water and glycerin are mixed, and acetic acid is added in the proportion of two or three drops to the ounce. The glycerin is then colored with the anilin solution. Starches mounted in the blue glycerin retain their natural appearance in a blue field; the effect is said to be "most beautiful."

—We take pleasure in calling the attention of our readers who are interested in medical science, to *Walsh's Retrospect*, a Quarterly Compendium of American Medicine and Surgery, published at Washington, D. C. It affords a most excellent epitome of the principal original medical articles published during each quarter; for this reason, it is one of our most valued medical exchanges.

MICROSCOPICAL SOCIETIES.

CENTRAL NEW YORK.

A regular meeting of this Club was held on the evening of Tuesday, April 26th, at the office of Dr. Aberdein, in Syracuse.

The Secretary read a paper sent by S. A. Webb, Esq., of Oswego, containing an account of some original observations on the mode of reproduction by segmentation of *Chilodon cucullus*.

Dr. W. W. Munson, of Otisco, then gave an informal talk on the anatomy of the flea of the woodchuck, *Pulex arctomys*. The Doctor began with an explanation of the mouth parts, and followed, through the thorax and abdomen, to the pygidium, illustrating his remarks by slides showing each of the organs, mounted in balsam by the carbolic acid process. The dissection was beautifully done, and was accomplished, for the most part, without the aid of a magnifier.

ONEIDA CO., N. Y.

A regular meeting of this Society was held in its rooms Monday evening, April 25th. The President occupied an hour very pleasantly in describing his method of mounting opaque objects, and in describing and commenting upon the Gundlach stands and objectives exhibited by Mr. Hodges; the "physicians'" stand was fitted with Gundlach's new fine adjustment which was greatly admired for its delicate and sensitive motion. Mr. H. C. Maine, of Rochester, was invited to attend the May meeting, and speak upon the subject to which he has given so much time and study—diatoms.

GEORGE C. HODGES, *Secretary*.

OSWEGO, N. Y.

A Society to be known as the Oswego Microscopical Society has been formed at Oswego, N. Y. President, S. A. Webb; Vice-Presidents, E. D. Milliken and E. Burrows, M. D.; Treasurer, Rev. Father Meagher; Recording Secretary, Thomas McGinnis; Corresponding Secretary, Miss Julia B. Douglas. It has already about fifteen members, and fair prospects of doing some good work in the various departments of microscopy.

WELLESLEY COLLEGE, MASS.

The regular meeting was held Monday evening, April 25th, the Vice-President, Miss French, in the chair.

Professor Nunn gave a very interesting talk on Embryology, the material for which was derived from observations made by her during the summer of 1879, on the Mnemlopsis, an animal of the genus Ctenophore.

Miss Nunn accompanied her remarks by drawings made on the spot, as the object required.

Professor Whiting gave a description of the larynx, illustrated by a model, and several experiments in sound. This was to introduce several slides for the microscope, illustrating sections of the larynx, showing especially the vocal cords.

The Society had recently received sev-

* *Journal of the Quekett Club.*

eral very choice botanical slides, several of which were under the microscopes.

LUCIA F. CLARK, *Cor. Secretary.*

ILLINOIS STATE.

The annual meeting was held April 22d, 1881, Mr. B. W. Thomas, the President, in the chair. Dr. McIntosh exhibited a new and improved microscope, combining an oxyhydrogen attachment. The histological slides shown by this apparatus were fine, and called forth very general admiration. Afterward the Society proceeded to the election of officers, resulting as follows:—

President, Dr. Lester Curtis; Vice-Presidents, Dr. Frederick W. Mercer, Prof. E. S. Bastin; Secretary, William Hoskins; Cor. Secretary, E. B. Stewart; Treasurer, W. H. Summers; Trustees, E. J. Hill, B. W. Thomas, W. H. Bulloch, Chas. E. Boring.

CENTRAL ILLINOIS.

The regular meeting of this Society was held April 21st, President F. L. Matthews in the chair.

After the routine business was finished the Society listened to a paper from T. B. Jennings, of the United States Signal Corps. His subject was "Protophytes and Protozoa, or the Simplest Forms of Vegetable and Animal Life compared." He first explained the composition of the vegetable cell, showing that it consisted of the cell-wall and cell-contents, that the cell-wall is composed of two layers of very different composition and properties—the inner, or primordial utricle, being the one first formed is essential to the existence of the cell, while the external layer, though commonly supposed to be the proper cell-wall, is really only generated, as a protective covering. He also explained the difference between the simplest vegetable and animal forms, and stated that the best guide for distinguishing them was that given by Dr. Carpenter, depending upon "The nature of the aliment of the Protophyta and Protozoa, and the method of its introduction." The Prophyte absorbs its nutriment from the air and moisture surrounding it, the same as the highest plants; while the Protozoa, in common with the highest animals, obtain their food from organic substances, which are taken up and then digested.

Dr. Matthews had a live fish under his large Crouch instrument, showing the circulation.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Living *Volvox globator*, in any quantity, for mounted Algæ or other slides.
J. M. ADAMS, Watertown, N. Y.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Section of Brain, stained, showing Tubercular Meningites; also Carcinoma Cerebri. Please send list.
L. BREWER HALL, M. D., 27 South 16th Street.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoæ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides.*
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

Well-mounted diatoms, in exchange for *any well-mounted slides* or material, etc.
W. H. CURTIS, Haverhill, Mass.

For diatoms *in situ* on Algæ, send mounted slides.
K. M. CUNNINGHAM, Box 874, Mobile, Ala.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Slides of hair of *Tarantula*, very curious; also crystalline deposits from urine, to exchange for well-mounted slides. S. E. STILES, M. D.,
109 Cumberland St., Brooklyn, N. Y.

Fine injected specimens of kidney, tongue and liver, also very fine slides of human tooth, prepared according to the method of Dr. Bödecker, showing the protoplasmic net-work between the dentinal canaliculi, in exchange for first-class histological and pathological slides, or other good specimens.
J. L. WILLIAMS, North Vassalboro, Me.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

Diatomaceæ from Lake Michigan (Chicago water supply), mounted or raw material; also diatoms from other localities, to exchange for well-mounted Diatomaceæ or other objects of interest. B. W. THOMAS,
1842 Indiana Ave., Chicago, Ills.

Lime sand, composed almost exclusively of microscopic Foraminifera, to exchange for microscopic material. H. A. GREEN, Atco, N. J.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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Notes on Microscopical Technology.

BY C. E. HANAMAN.

I.

The journals devoted to microscopical subjects literally teem, now-a-days, with articles on microscopical technology. Old devices are reinvented or slightly modified, and, in spite of editorial vigilance, are published as new, together with a multitude of methods of preparation, etc., many of which can be successfully used by none but their inventors, owing to the fact that they have not been thoroughly tested by their authors, or because minor, but nevertheless essential, details of their application, have been omitted.

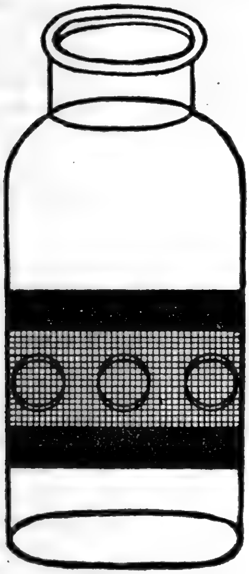

FIG. 25.

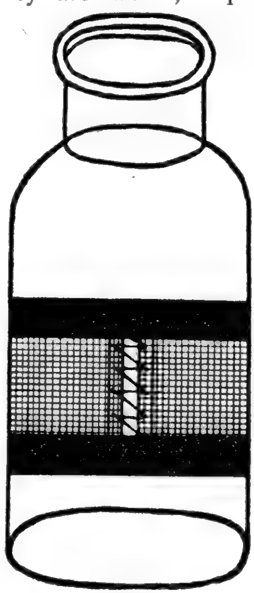

FIG. 26.

In view of these facts, it is with much hesitancy that I submit the following devices and methods of work. I believe them to be new; and a number of persons to whom they have been shown have found them useful. I submit them, however, for what they are worth, hoping that some of the readers of this JOURNAL, besides myself, may be helped in their work by their use. If they are old, and have, by some, "been used for years," I shall gladly yield the "honor" of their invention, to which I attach very little importance.

The first device which I shall submit is a form of collecting bottle, which has worked better for me than the well-known, and many times reinvented, "Wright's Collecting Bottle."

It consists, as shown in Figs. 25 and 26, of an ordinary wide-mouth bottle or fruit-jar, having a number of holes (Fig. 25) half an inch, or more, in diameter, bored through the side, at a distance from the bottom corresponding to the capacity of the bottles in which the collector intends to bring home his material. Over the holes, and around the bottle, is tightly tied, or laced (Fig. 26), a piece of fine muslin, which should be at least three times as wide as the holes in the bottle. Over the muslin, both above and below the holes, a rubber is placed so as to make all water tight, except at the points corresponding to the holes.

Now, any quantity of water may be poured into the bottle, and it will rapidly run out through the muslin covering the holes, leaving the organisms which it contained in the bottle, together with only so much water as the lower part of the bottle, below the holes, will hold. This can then be poured into smaller bottles for transportation, by so inclining the collecting bottle as to allow its contents to run out on the unperforated side. More straining surface can thus be gained, and the nuisance of funnels (necessary in the Wright's form) be dispensed with.

The principle upon which this bottle is constructed is subject to a variety of modifications.

For instance, a slit of any width, from half to one inch, may be filed in the side of a fruit jar, and thus additional straining surface be gained; or, a tin or zinc can may be used, having a broad slit in its side over which the muslin can be stretched.

If it is preferred to have the strainer inside the vessel, this can be easily arranged by using a vessel with a slit, and placing a diaphragm of thin iron (ferrotype plate) inside, somewhat wider and longer than the slit in the vessel, and having in its centre a slit of the same size as that in the vessel used.

A piece of muslin can be drawn over the diaphragm, covering its side next the interior of the vessel and passing over the edges, thence upwards, downwards, and laterally through the slit in the vessel and around the outside of the same, as in the former case, rubber bands being applied as before over the upper and under edges of the muslin. I do not think there is any particular advantage to be gained by this mode of construction, but it is suggested as a modification which may be deemed desirable by some. It is necessary that the holes in the vessel be bored at some distance from the top of the bottle, in order to get sufficient weight of water to force itself rapidly through the strainer. If the holes are made near the top of the vessel, it will not work much more rapidly than the Wright's form, although even in that case the absence of funnels is a great convenience.

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The Detection of Adulteration in Food.

BY C. M. VORCE, F. R. M. S.

III.—Tea.

In examining a sample of tea for adulteration, the first process is to sift it, or to otherwise separate the fine dust from the leaves, etc. Having done this, put a quantity of the leaves to soak in some warm water. On examining the dry dust with the microscope, if the tea was good, we shall find the dust to be almost entirely composed of fine fragments of the leaves, detached hairs like those in Fig. 5, a few particles of Prussian blue, and such particles of sand, fibres, etc., as are always present in any substance that has been more or less exposed to dust. The poorer the sample of tea is, the greater will be the quantity of siftings, and the more dirt, dust, fibres and coloring matter are found; there usually is, according to my experience, a considerable quantity of what appears to be simply dried and powdered blue

clay. This blueish, finely pulverized matter is insoluble in water, apparently unaffected by acids; and I am unable to distinguish it from clay suspended in water and allowed to settle on a slide. My inference is that the cheap tea that shows this fine, granular substance is sprinkled, while damp or wet, with the dry, powdered clay which adheres to it as it dries, thus increasing its weight. It is also possible that the steeped leaves, which have served to furnish the extract of tea used to flavor other leaves, are thus treated with clay, and dried so as to be sold again as tea, at a low price. In the poorest sample of tea that I could find for sale (retailed at twenty-five cents a pound), there were present a large amount of stems of some bush, which I could not assert were not tea stems, also pieces of the stalk of some grass, very like the common timothy grass, somewhat colored, and undoubtedly flavored by soaking in extract of tea; also a considerable number of pieces of the stem of some pithy weed, and a few fragments of some starchy seed, either peas or beans, which, however, may have been accidentally present; splinters of some coniferous wood, also possibly accidental; considerable sand, much of the clay, or some similar substance already alluded to, and a good many fragments of a blue coloring matter soluble in water. The leaves representing tea in this sample were mostly matted into flat wads, instead of having the loose, rolled appearance characteristic of most teas, and had probably either been steeped for extract, or been wet and redried. Yet this sample of tea had a very good fragrance and taste; and when some of it was steeped and placed on the table, it was at first pronounced by those who tasted it, "pretty good tea;" but when they were told its cost and what it contained, it grew worse in their estimation with each successive test, and its defects multiplied until it was pronounced "wretched," and the remainder was thrown away. As I do not drink tea myself, I was unable to satisfactorily compare this sample with good tea in the usual manner; but the experiment illustrates how little risk there is that a skilful adulteration would be detected by consumers generally, nearly all of whom suppose they are using a first-class article, or at least a pure one. The structure of the leaves in this sample of a cheap tea will be referred to further on.

Taking now the tea leaves which were put to soak, and which have unfolded and become soft, we proceed to minutely examine the structure of the leaves, so as to know whether any leaves we may find in a sample purporting to be tea, are tea-leaves or not. The upper surface of the tea-leaf is smooth, without hairs or stomata, and, in its soft and swelled condition, when examined in water and glycerin with one-inch objective, shows the surface to be composed of angular cells, loosely arranged, some oval or circular, with considerable space between, with a tendency to fall into rows corresponding with the net-work of spiral vessels (Fig. 1). An occasional clear space (empty cell) looks like a hole extending into the leaf (*a.* Fig. 1). The net-work of spiral vessels is very close and tortuous. The under surface bears many long, slender, simple, pointed hairs, without divisions (Fig. 7). The cells are packed, and the stomata exceedingly numerous (Fig. 2), and there are no open spaces to be seen. A section of the leaf (Fig. 8) shows that the cells on the upper side are attached by the end for two layers in depth, then come the T-shaped cells throughout the substance of the leaf, with one layer of cells lying flat on the under surface, and gradually merging into the heterogeneous arrangement of the middle part. Stripping off the cuticles from each surface, and examining them in the same medium, we find the actual cuticle of the under surface (Fig. 9)

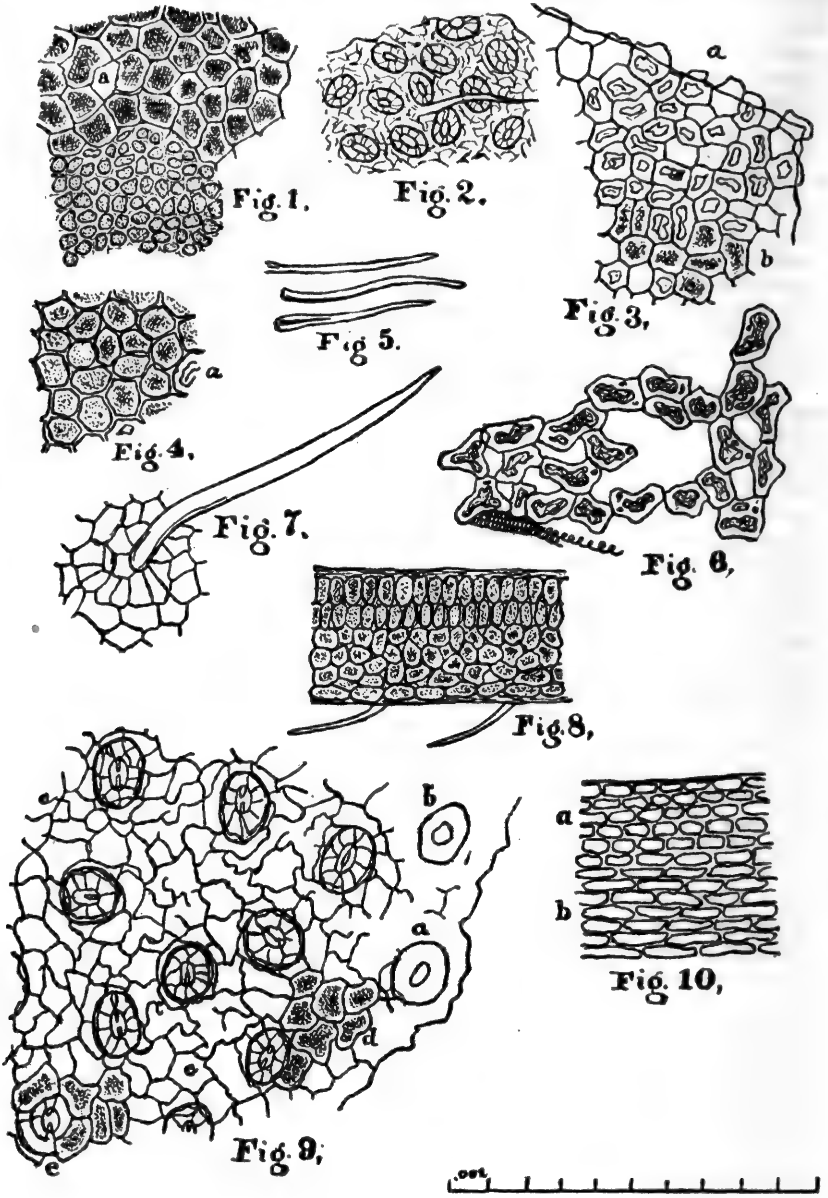

PLATE I.

DESCRIPTION OF THE PLATE.

Fig. 1. Upper surface of soaked tea-leaf. Upper part by ¼-inch, lower by 1-inch objective; *a*, an empty cell.
Fig. 2. Under surface, by 1-inch objective.
Fig. 3. Cuticle of upper surface, by ¼-inch objective; *a*, scales of cuticle; *b*, parenchymal cells adhering to the under side of the cuticle.
Fig. 4. Under side of upper cuticle, by ¼-inch objective; *a*, scales adhering to cuticle.
Fig. 5. Detached hairs, dry, by 1-inch objective.
Fig. 6. Parenchymal cells and spiral tissue, by ¼-inch objective.
Fig. 7. A hair of the under surface of a tea-leaf, by ¼-inch objective.
Fig. 8. Section of a tea-leaf, by 1-inch objective.
Fig. 9. Cuticle of under surface of a tea-leaf, by ¼-inch objective; *a*, *b*, stomata openings in the hyaline cuticle; *c*, remains of cell-walls adhering to cuticle; *d*, parenchymal cells adhering; *e*, cells overlying stomata.
Fig. 10. Cells of cuticle on the large veins of the leaf; *a*, from under surface; *b*, from upper surface.
Figures 6, 7 and 9 drawn with camera lucida; the scale given applies only to these three figures, and is in decimals of an inch.

to be a structureless, hyaline membrane, with stomata openings unmarked (Fig. 9, *a*, *b*). Remnants of the cell-walls are left attached when it is stripped off, leaving the outlines of the cells visible as clear hyaline lines (Fig. 9, *c*); often a layer of parenchymal cells remains attached (Fig. 9, *d*). The structure of the stomata remains in the tiers of cells joining the cuticle (Fig. 9, *e*). The hairs are shown in Fig. 7.

The cuticle of the upper surface appears smaller celled, by reason of the parenchymal cells being attached endwise; and the loose or scattering appearance of the cells arises from the cell contents being shrunken, and the cells being in two tiers. When the upper cuticle is cleanly stripped off, it is found to be hyaline, and discloses at its edge, flat, scale-like cells, adhering to its under side (Fig. 3, *a*), having a hyaline, scale-like substance enclosed. On the inside it shows the walls of the parenchymal cells adhering to the layer of scale-like cells (Fig. 4, *a*). On the large veins the cells of the upper cuticle are long, and arranged like brick work (Fig. 10, *b*). The cells of parenchyma forming the substance of the leaves are of various irregular shapes, but usually about twice as long as their width; many are triangular or T-shaped, and they are never, so far as I have observed, circular or oval. The most common shapes are shown in Fig. 6. The leaves of the very cheap tea above referred to were found to consist mostly of leaves having the shape of tea-leaves, but somewhat smaller, and of a yellowish tinge. The cells were of very similar shape and arrangement to those of tea, but considerably smaller. The hairs were also of the same shape and size, but they were hollow quite to the tips; and so numerous, that in some places the leaf seemed entirely covered with them. The stomata were of the same size and shape as those of the tea-leaf; and on the whole, it seems probable that these leaves were actually the leaves of some species of tea. The other impurities found cannot be described in detail, within the limits of this article. The adulteration is readily detected, however, by a knowledge of the structure of the leaves of genuine tea-leaves.

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The Epidermal Organs of Plants.

BY CHARLES F. COX, F.R.M.S.

(*Continued.*)

I will now pass to the physiological portion of my subject.

It is not to be doubted that such highly developed and specialized organs as plant-hairs have an important physiological office in the vegetable economy. Neither is it to be supposed that so large a part of the mere bulk of the plant is practically useless or only ornamental. The fact that the hairs of plants constitute a very large proportion of their substance, argues that they are not accidental or merely incidental growths, but that they must be exceedingly important organs to warrant such an expenditure of material and energy as is necessary for their production. We all appreciate the extraordinary quantity of material used to form the seed-hairs which constitute the commercial article, cotton; and all have observed the also lavish use of material made to produce the seed-hairs of the milk-weed and the thistle. These seed-hairs serve a useful purpose in the distribution of the seeds to a distance, thus disseminating the species to which they belong; but aside from this I believe that, in common with other plant-hairs, they serve an important physiological purpose before the seeds upon which they grow attain maturity.

It seems to me that light is thrown upon the office of plant-hairs in general, by what we know of the physiological uses of root-

hairs and the tentacular hairs of the insectivorous plants. Such hairs are primarily absorbing organs, taking up for the use of the plant not only nitrogen and nitrogenous compounds, but probably also oxygen.

It is generally agreed that there are but two principal physiological processes going on in the plant, namely, assimilation (the elaboration of organic compounds out of inorganic), and metastasis (the transmutation of one organic compound into another). Assimilation is that process by which carbon-dioxide and water are decomposed and their elements formed into what are known as the carbo-hydrates, of which starch is the most important. In this process oxygen is liberated and exhaled. Assimilation can take place only in the chlorophyll-bearing cells, in the presence of light and a certain degree of heat. The materials produced by this process are the only materials which are suitable for use as food for the protoplasmic basis of life in the plant, which is the seat of growth and reproduction. The process by which these carbo-hydrates are appropriated to the specific purposes of the plant, are transported from one part to another, and transmuted into active, living, propagating and then permanent vegetable tissue, is what is called metastasis. Inorganic substances cannot be directly appropriated by the protoplasm of the plant, except perhaps to a very limited extent in some special cases. Assimilation, therefore, is a somewhat doubtful name for a preparatory process, of which metastasis is the ultimate object. Metastasis is, therefore, really the assimilative process, and corresponds to the process to which the name assimilation is given in animal physiology; while assimilation, so-called in vegetable physiology, is more analagous to the preparatory process of digestion in animals. There is greater analogy between the vegetal process of metastasis and the animal process of assimilation from the fact that oxidation, by some sort of respiration or absorption from without, is an essential part of each.

It has already been stated that what is termed assimilation, takes place only in the chlorophyll-bearing cells in the presence of light and heat. Therefore, fungi, parasitical plants and, generally, plants which are destitute of chlorophyll, are unable to perform the assimilative process. They must therefore obtain for their food ready-made, organic compounds, and are, in this respect, like animals.

Unlike the process of assimilation, metastasis takes place in cells which do not bear chlorophyll, or else in the chlorophyll-cells in the absence of light; and while the assimilative process is promoted by light and warmth, the metastatic process is promoted by darkness and probably by a lower temperature. What aids the one process retards the other; so that the assimilative process is active in the day-time when the metastatic process is checked, and the latter process is active at night when assimilation is checked. Day-time is therefore the period of preparation, and night time the period of growth in plants. In the day-time they take up and decompose the compounds from which the carbo-hydrates are formed, at the same time exhaling oxygen, and at night they inspire oxygen for the purposes of internal change and growth, at that time exhaling the products of oxidation, which consist mostly of carbon-dioxide. Now this fact is to be particularly noted, that the protoplasm of the plant is its life-bearing element, and that the process of metastasis is a process directly connected with the preservation, augmentation, modification and reproduction of this life-bearing element; while the process called assimilation is almost purely chemical, and has for its result merely the production of appropriate material for the metastatic process.

It has been shown that the rotation

of protoplasm in the plant-cell is not aided by light, if, indeed, it does not take place more readily in the dark. It has also been shown that it cannot take place without a supply of oxygen. It is also a familiar fact that the rotation of protoplasm is common in plant-hairs, in which it may be seen under the microscope. A favorite object for this purpose used to be the stinging hair of the nettle, but the cyclosis is easily seen in many other hairs, particularly in the segmented hairs on the stamens of *Tradescantia* and in the leaf-hairs of the pansy or of the holly-hock. The facts I have just referred to serve to connect the hairs with the protoplasmic portion of the plant and, through it, with the process of metastasis.

As there are two essential physiological processes in plant-life, so there are two principal sets of organs for the effecting of these processes, namely, the chlorophyll-cells with their appendages, and the circulatory system with its appendages. The former system is apparently much the simpler, and consists of little besides the chlorophyll-cells themselves (which are parenchymal cells), with the stomata, their means of communication with the external air. But the circulatory system begins in the roots, follows the trunk, branches, stems and petioles, and spreads out in a finely ramified network of veins in the leaf, the latter being merely the extension of the fibro-vascular bundles from the petiole into the leaf.

Circulation in the plant is dependent upon evaporation from its surfaces. The leaves promote evaporation, and the lost moisture is made good mainly by absorption of water through the roots. There are reasons for supposing that the stomata are the chief organs of evaporation, especially in those plants which have a dense and impervious cuticle. But there are also good reasons for believing that the stomata have other offices besides merely facilitating evaporation. There can be but little doubt that they are also the means of communication between the external atmosphere and the internal chlorophyll-bearing cells through which the supply of materials is obtained for the process of assimilation already described. Such a relation between the stomata and the chlorophyll-cells is at once suggested by the fact that the stomata are invariably directly over intercellular cavities; and it is confirmed by the fact that they open in the presence of light and close in darkness, being ready for duty only at a time when the assimilative process is active. If the function of evaporation were their sole office, one would suppose that they would be most open when evaporation was least active (in the shade), and more closed when evaporation was likely to be too rapid (in the sunlight), acting, in this respect, like the governor on an engine.

While there is much evidence that the stomata are organs of the assimilative process, there is quite as much evidence that they are not connected with the metastatic process. Of this negative evidence we recall at once the fact that the stomata are never found upon the fibro-vascular veins of the leaf. Other negative evidence will suggest itself as the converse of postive evidence which will hereafter be mentioned as showing that the hairs are connected with, and are organs of, the metastatic process.

Several recent observers of plant-hairs have attempted to account for their existence; but no one, as far as I know, has done so upon purely physiological grounds. To my mind, however, the evidence that hairs are primarily organs of the metastatic process, strengthens with each new fact that comes to my knowledge. This theory is not affected by the fact that not all plants in all stages of their existence are hairy, because, probably no process in vegetable physiology is performed in precisely the same manner,

and by exactly the same means throughout the whole kingdom. Nor is the theory weakened because hairs often serve other purposes than strictly physiological ones, for nothing is more common than for an organ, or part, to become modified or specialized for an office for which it was not primarily intended. Thus it is by no means strange if hairs, while essentially organs of the physiological process of metastasis, should be utilized for purposes of protection against cold or dryness, as has been suggested by some of the writers to whom I have alluded. I have no doubt that they are in most instances correct in their inference that great hairiness or wooliness may be a protection against sudden changes of temperature, or a check upon too rapid evaporation. Nevertheless, I cannot find that unusual pubescence is generally associated with a warm, or a cold, or a dry climate, although this last relation is the most plausible. It seems to be a fact, however, that the hairiness of a plant bears some proportion to the general sterility of the region in which the plant grows. In confirmation of this I am informed that, in the sterile regions of our western territories, not only do the more hairy species and genera prevail, but those which are hairy elsewhere are especially so there.

Mr. Charles Darwin is plainly of the opinion that the saprophytic habit of the so-called insectivorous land plants is the result of a struggle against sterility of soil, but not particularly against dryness; for while these plants usually inhabit sandy or barren regions, they quite as commonly grow in very wet places. Such being the case, it seems altogether natural that we should find a general increase of pubescence in the plants of a desert region; for what is the cause of a most remarkable specialization in the case of the insectivorous plants, may readily be conceived to be the cause of a less remarkable modification in the general flora of a district. A further fact, strengthening this idea, has also been noticed by Mr. Darwin, in his work on insectivorous plants, viz.: that the high degree of specialization in the glandular hairs of these plants is associated with smallness of the roots, the latter being in most cases barely of sufficient size to collect water from the soil. In some genera, indeed, as, for instance, in *Dionæa*, the plant does not seem to depend upon the soil at all, for this plant may be grown epiphytically upon moist cotton or sponge.

It is well known that roots and foliage-branches are homologous parts, so that in some plants they may easily be made to exchange places and functions, the branches when planted in the soil running to roots, and the roots when turned upwards developing into foliage. It is therefore not astonishing that, in their natural position the roots and their appendages and the leaves and their appendages should maintain a more or less steady equilibrium. When, for any reason, the plant does not find use for the natural root functions, we should expect it to transfer them to the leaf if possible; and where the supply of oxygen and nitrogen compounds is cut off at the root—as it is in a desert region—it is quite in accordance with analogy that the leaf organs should be unusually developed, for the purpose of increasing the supply of oxygen or of nitrogenous compounds through the leaf. This will be particularly the case when the assimilative process is not active, and when the plant must therefore, rely more upon obtaining organic compounds ready-made than upon making them itself.

Aside from the question of the abundance or scarcity of food, the plant's means of appropriating its food-elements must be in proportion to the requirements of growth. That is to say, other things being equal, a rapidly growing plant, or part of a plant, is more likely to be hairy than is a slow-

ly growing plant or part. On this principle, as I have already mentioned, the newest part of a plant, whether leaf-bud or flower-bud, is usually the most pubescent part.

It is not easy to account for all the differences among genera, as to hairiness or smoothness, but I have no doubt that ultimately it will be ascertained pretty nearly why each different genus is or is not hairy; for I do not think there can be a doubt that every such difference has a reason, founded in general laws, in the main physiological.

In the insectivorous plants some of the hairs are adapted to a use not strictly physiological, namely, the alluring and capturing of prey. For this reason they have become most developed and modified on the upper instead of the lower side of the leaf. It is not unusual, however, to find organs of every kind which have become specialized for peculiar purposes; and an instance, somewhat in the line of the alluring bait of some of the insectivorous plants, is the change which a simple gland, such as we find on many leaves and petals, is supposed to have undergone, in order to produce the nectary of the flower.

Where hairs have not been modified for unusual purposes, we can see reasons why they should grow most abundantly and luxuriantly on the under side of the leaf. In the first place, the hairs, being organs of the metastatic process, naturally grow, under ordinary circumstances, where that process is best promoted, namely, in the shade, where also, for the same reason, are the veins with which the hairs are connected. But aside from this, it seems to me not merely a fancy that, as the upper side of the leaf is the one where the chlorophyll-cells most naturally abound, it should be free from any organs which would cut off the full supply of light and heat which is necessary to the operation of their functions. Moreover, since the stomata open in the light, and evaporation is hastened by heat, the under side of the leaf seems to be the better place for them, for there they are less liable to unrestrained action which would be disturbing and dangerous to the plant. Besides this, we can see that it is an economical arrangement that hairs and stomata should exist together, chiefly for the reason already referred to, that the hairs probably help to retain moisture and check too rapid evaporation.

After this hasty and necessarily imperfect summary of the more general facts known as to external epidermal organs, I wish now to call attention briefly to some facts concerning analogous internal organs. These are particularly the internal hairs of some water plants, of the genera *Nymphæa* and *Nuphar*.

If we examine with the microscope a section of the leaf, or the petiole, of a plant from either of these genera, we are at once struck by certain abundant, thickened, branching, unicellular structures scattered through the parenchyma and projecting into the intercellular spaces. These structures have long attracted the attention of microscopists, but not until recently have they been distinctly recognized as internal hairs. The standard text-books of the microscope, such as Carpenter's and the Micrographic Dictionary, refer rather doubtfully to the resemblance between these bodies and the stellate external hairs of *Deutzia* and *Alyssum*, but they generally shyly avoid calling them plainly internal hairs. Some writers speak of them as "stellate parenchymal cells;" and on a purchased slide which I own, they are described as "stellate raphides." But out of the confusion and uncertainty which has prevailed with regard to these structures, there has gradually crystallized a clear and definite recognition of the fact that they really are epidermal organs, exactly analogous to the external hairs of terrestrial plants, such as we have been considering.

In the first place, the mere morphology of these structures confirms the idea of their being truly hairs. In their outlines they so closely resemble some of the external hairs with which we are familiar (for instance those of the genus *Arabis*), that their analogy is at once suggested to the observer. They seem, however, to be always unicellular growths, and transverse sections show them to be hollow. Over their surfaces are scattered the grains of silex, so characteristic of other hairs, and made particularly familiar to us by the hairs of the Deutzias. If one wishes a striking demonstration of the mere resemblance of these internal hairs to better known external hairs, he has only to split the petiole of *Nuphar* or *Nymphæa* by tearing, and view it with the binocular as an opaque object. This, of itself, will be convincing to most persons acquainted with the peculiarities of leaf-hairs.

But, aside from configuration and other merely morphological considerations, the mode of distribution of these internal hairs is almost precisely like that of external hairs. If we take a thin section of a leaf of *Nymphæa*, cut parellel to its surface, and examine it as a transparent object (still better if we illuminate it with polarized light), we shall see that these internal hairs, like external ones, are associated with the fibro-vascular system; and toward the margin of the leaf, where the tissues are thin and the veins small, we shall find that the hairs exist only upon the veins and not between them. This is quite in accordance with what we know of the habit of all hairs, as I have already explained.

If we take a transverse section of the leaf of *Nymphæa* or *Nuphar*, cut across the mid-rib, we shall be struck by another fact connecting these internal hairs with the epidermal system. We shall at once notice that from the upper side of the leaf—which is, under common circumstances, the only side exposed to the air, and is consequently the only side possessing a true epidermis—these hairs spring like stumps of trees in an inverted field. From end to end of the section they will be observed planted close together, their pedicels imbedded in, or forming a part of, the epidermal layer, and their branches spreading downward and inward through the underlying parenchymal tissue. This is very marked in stained sections, in which the hairs take a darker color than the surrounding tissues; but in an unstained section, polarized light differentiates the structures quite as well as the elaborate, double-staining process now so commonly employed. It is to be noted that this arrangement of the hairs is confined to the upper or epidermal side of the leaf, and that no similar arrangement is to be seen at any other part. The distribution of the hairs on the interior of the petiole of the water plants is somewhat different from their arrangement on the interior of the leaf, but it is closely analogous to the arrangement of hairs upon the exterior of the petiole of land-plants.

I have referred to the fact that these internal hairs are good objects upon which to use polarized light; and this is a point of no small importance in the argument for their being actually hairs. To any one acquainted with the behavior of vegetable tissues with the polariscope, particularly of vegetable hairs, the manner in which these internal structures of the Nymphæaceæ are affected by polarized light is strong confirmation of their claim to be regarded as epidermal organs and true hairs. The way in which they take different colors in the process of double staining, will be another affirmative argument with those familiar with that process and its effects. Suffice it to say in this connection, that these internal hairs behave in precisely the way, and take exactly the colors, that external hairs do.

That structures physiologically referable to the epidermal system should be found growing in the midst of the parenchymal system, is not altogether anomalous, for sections of the leaf and petal of *Magnolia grandiflora* reveal an abundance of thickened, irregular, unicellular structures scattered through the parenchyma, which, both in their appearance and in their mode of distribution, at once suggest some sort of similarity to the internal hairs of *Nymphæa* and *Nuphar;* but which, in my judgement, are parts of the glandular system of the Magnolia. Indeed, any true sunken gland may be regarded as an internal epidermal organ.

Plants which do not live either entirely in the water or entirely out of it may naturally be expected to occupy, so far as their organization is concerned, a position intermediate between submerged plants and aerial plants. Such is the case with the Nymphæaceæ. While not relinquishing their dependence upon, and their connection with, the external atmosphere, they nevertheless provide against partial submergence, by an increase of their capacity for internal interchange of the gases necessary for their life and growth. In other words the amount of external surface exposed to the atmosphere being largely curtailed, by reason of their partial submergence, this loss is compensated for by a great increase in the amount of internal surface exposed to the air and gases contained in the intercellular spaces. By this enlargement of the intercellular spaces the inside of the plant becomes (if I may be allowed the paradox) to some extent, for physiological purposes another outside; and the practical effect is the same as if there were less intercellular space, and more surface exposed to the outer atmosphere. To the same extent as the inside becomes practically a part of the outside, by reason of its exposure to surrounding air and gases, that part of the outside which is submerged becomes practically part of the inside, by reason of its exposure to the surrounding fluid.

In plants existing under such peculiar circumstances, we need not be surprised to find organs and tissues which, in strictly terrestrial plants, are external, becoming internal. And so there is no *à priori* reason against the existence of internal hairs, or even of a whole internal epidermal system, in the Nymphæaceæ. But we have no warrant for looking for internal hairs in all partially submerged, or wholly aquatic, plants, any more than we have for expecting to find external hairs upon all terrestrial or aerial plants. As a matter of fact, hairs do not exist upon many land-plants which seem to grow under the same circumstances and surroundings as others, upon which hairs are found; and so, while *Nymphæa* and *Nuphar* are internally pubescent, *Nelubium* and *Bracenia* are internally glabrous. It is no easier to account for this difference in land-plants than it is in water-plants; but in both cases it is doubtless caused by some fundamental, physiological difference at present unknown.

That the great enlargement of the intercellular spaces in submerged, or partly submerged, plants, is for the purpose of facilitating the internal interchange of gases which, in plants growing upon the land, would take place externally, is no new theory of my own. Sachs, in his "Botanical Text-Book," says:—

"A submerged water-plant, for example, which contains chlorophyll, absorbs carbon dioxide from without, under the influence of sunlight; and at least a portion of the disengaged oxygen collects in the cavities. When it becomes dark this process ceases; the collected oxygen is now absorbed by the fluids of the tissue, and gradually transformed into carbon dioxide, which can again diffuse back into the cavities, but partially also through the layers of tissue into the surround-water."

In the light of these facts we can perceive how the interior of a water-plant may become of more importance to it than the exterior, for most physiological purposes, and under these circumstances it is not strange that we find such important organs of the metastatic process as the hairs, transferred from the exterior to the interior, where the amount of surface exposed to the interchanging gases is many times greater than that exposed to the external atmosphere.

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The Microscopic Limit and Beyond.*

Increased skill and ever-extending knowledge may enable the scientific worker not only to reach the utmost limit of inquiry in his time, but possibly to gratify that constant desire to see into the limitless region which lies beyond the bounds of actual investigation. This is the hope which encourages the thoughtful observer; for who would not consent to spend years in patient research, if by so doing he could succeed, as it were, in projecting his intellect, were it ever so short a distance, beyond the circumscribed region in which the senses can alone operate? Failures and disappointments may be endured if only the observer's mind be buoyed up by the hope that ere his nerve-tissues grow too old, and begin to fail, the longing of his intellect will probably be gratified. To many, indeed, who are unable or unwilling to look into the secrets of nature, such hopes and desires will seem unintelligible or incredible. They will be regarded as the idle fancies of an idle mind; and the ardent scientific inquirer will be pitied or condemned as a weak, foolish person who, like a child, is unable to repress his morbid curiosity to peer into the unseen, and his craving to know the unknowable;—as one deserving to be classed with simpletons and madmen, on the ground that it is absurd to suppose that a really sensible person would spend his life in hard work without remuneration, in preference to doing that which would enable him to gain wealth, and to live at ease, if not in luxury and enjoyment. And certainly it must be confessed that in few departments of research is there less prospect of gaining by success such rewards as are generally sought for, than in the one to which we are attached.

The microscopist, like the astronomer, is ever longing to get a little beyond the point at which he has already arrived. Each new fact gained by research seems but to indicate the existence of more and more important things beyond. Limit is reached and then surmounted, but soon a new limit seems to rise from the mists in the distance, towards which the worker is impelled by new hopes and desires. It is this never halting progress which distinguishes scientific from any other kind of inquiry, and particularly microscopical investigation, for it can never be completed. It deals with the illimitable. The boundaries of to-day are found to have vanished to-morrow, and the eyes and understanding begin to penetrate into regions which but a short time before had been considered far beyond the range of possible investigation. * * * * * * * *

Our present limit of observation in investigations on the structure and action of the tissues of man and the higher animals, in my opinion, includes the use of magnifying powers of upwards of 2,000 diameters. Objects considerably less than the hundred thousandth of an inch in diameter can be studied with success, but how much less than these dimensions cannot, I think, be determined with accuracy at this time; for so much depends upon the character of the object, and a number of small points of detail as regards the mode

* Extracts from the presidential address of Lionel S. Beale, F.R.S., delivered before the Royal Microscopical Society, London, at the annual meeting, February 9th, 1881.

of examination. * * * * * *

To my mind, the study, with the aid of high powers and various improved means of examination, of the phenomena which occur in living matter during life, transcends in importance at this time all other inquiries in which the microscope takes a leading part. For these changes characterize every form of living matter at every period of its being, and in every condition of health and disease. In every form of living matter which exists or has ever existed, the great mystery of life and death is enacted under our very eyes, but we have not yet been able to discover the exact nature of the change, though we can prove most conclusively that it is not merely mechanical or chemical, as some pertinaciously insist. No chemist or physicist has been able to explain the changes which do occur, or has succeeded in imitating them out of the living body. The most diverse structures and the most widely different chemical compounds are produced by changes occurring in particles of living matter which could not be distinguished from one another, and which are equally devoid of color and structure. Many of the current theories on the nature of vital phenomena are not in advance of some that were propounded two thousand years ago; and yet men occupying high scientific positions are found to defend them, and to repeat again and again statements concerning the relation between the living and non-living, which are at variance, not only with facts familiar to every one, but are contradicted by the experience and knowledge every person possesses concerning certain vital phenomena of his own organism.

When a particle of living matter is increasing in size—is growing by taking lifeless matter into its substance, and, without itself losing anything, is communicating to certain of the elements of this non-living matter, or to combinations of these, the marvellous powers it possesses—movements take place, it may be in every part of the original mass. These movements are, however, always most observable, most active, and most extensive at some part of the circumference. Occurring now on one side, now on the opposite, it is very improbable that the movements in question are determined by any changes occurring in, or by force belonging to, any non-living matter in the vicinity of the living mass. These remarkable movements are universal in the world of life. They are more accelerated in some kinds of living matter than in others, but they are present in all, and in most are discernible at some time or other during the course of existence. Parts of the living matter continually tend to move away and separate from the rest, not in consequence of any attraction between these and surrounding matters outside, nor from any repelling influence exerted by parts of the mass itself upon other parts. There seems to be an active tendency on the part of different portions of a living mass to move away from the rest and so to detach themselves, and, having acquired vital power, to become independent, and to increase and then divide. This remarkable tendency on the part of every kind of living matter to divide and subdivide begins to operate as soon as the original mass has attained a certain size, and it seems to increase in intensity as the living matter approaches its proper dimensions. Invariably when a certain size has been reached, which, however, is different for different kinds of living matter, division occurs. This size is always, within certain very moderate limits, fixed and definite for the living matter of each particular species of living being. Among the lowest forms of existence, however, no definite limit of size has to be attained before division can occur. Particles smaller than the smallest particles that can be seen with the aid of the highest magnifying powers freely divide and

subdivide, and there is reason to think that under certain conditions the division and infinite multiplication of the animate particles may continue for a considerable time, none of them attaining their fully developed form or dimensions. In higher forms of life, premature division of a living mass before it has grown for a proper time and reached a certain size, is very detrimental, and in many cases disastrous ; for it is associated with degradation or even complete loss of formative, constructive, and developmental power. In some cases, by the rapid multiplication and division of the particles, the well-being of the whole organism is jeopardized, and death may be occasioned by the changes brought about by great increase and rapid growth and multiplication of certain particles of living matter belonging to the blood or to some of the tissues.

When a portion of a mass of living matter moves away from the rest, the moving portion invariably presents a convex surface, of which the portion in the exact centre is of course in advance of the rest and is the point towards which the movement of adjacent portions tends. It almost seems as if one minute portion had moved away from the rest and had dragged with it neighboring portions, the power of the particles constituting which was not strong enough to act in opposition to it or to resist its influence. These seem to yield and follow the one or few particles in which the movement is strongest, and which seem to act the part of leader. It may be that certain particles here and there, having attained a larger size, or from being more active than the rest, move forward and determine the direction which is to be taken by those near. As far as can be seen, multitudes of living particles stream in one direction, the greater number being either carried along by the very few, or irrisistibly drawn onwards by them. * * *

I dare say that for some time to come it will be most difficult to get a hearing for any views not in accord with the materialist tendencies of what is miscalled the *science* of our time. Thought is to be crushed, and any speculations are to be condemned which do not happen to favor the arbitrary dogmas of the purely physical school. But no doubt these attempts, like preceding ones of the same order, made at different periods of history, —although they may succeed for a time, and by them people may be driven away from the truth—will ere long be given up. They may be safely left to the gradual process of disintegration and ultimate dissipation by which these and such-like fancies of physical ingenuity will be disposed of. As I have shown elsewhere, whenever tissue and other matters peculiar to living beings are to be formed, living matter undergoes change. In fact, the act of forming these things corresponds with the cessation of life in the particles.

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If now I permit myself to pass beyond the point to which I have been led by actual observation,—if I try to advance beyond the present microscopic limit, travelling as it were upon the same lines as when observing within it, and try to realize the phenomena which occur during the early period of development of some comparatively simple vegetable tissue, a leaf for example,—I think the following description will not be far from the truth : A mass of living matter, endowed with special powers working under certain definite conditions, takes up certain materials and increases in size thereby. Imparting to the new matter its powers, unweakened in force, as it grows, it soon divides into several portions, each of which in like manner grows and divides. The arrangement of the several masses, though fixed within certain limits, is determined not by any forces, powers, attractions or repulsions acting upon all of them, but simply by the rate of growth of each,

and division of the several masses under then existing external conditions; the dimensions each was to attain, as well as its properties, composition, color, and the like being due to the life, force, or power each separate mass derived from the parental one which gave it origin, and from which it had been detached. But while the above phenomena are proceeding, changes are also occurring on the surface of each mass. The living matter in this situation, whether from the particles first formed, and being therefore the oldest, reaching the surface, and coming to the end of their living existence, or from some other cause I cannot say—passes out of the living state, and the component particles, or certain of them, combine, assume a certain form, and acquire physical properties they never possessed before. The formed material thus produced owes its color, chemical composition, physical characters, internal structure, and the like, to the vital force or property in obedience to which the elements of the matter were made to occupy such positions and assume such relations, with respect to one another, just before death as must ensure the formation of the particular substances which result. * * *

There is not, I think, any good reason for accepting the conclusion that one of a collection of elementary parts, at any period of development, can sympathize or otherwise influence the actions of others, as Virchow seems to think. The suggestion that any force or power acting, as it were, from a centre, governs, regulates and determines the changes taking place in surrounding and more or less distant particles, is, in my opinion, inadmissible. * * * * * * *

One can indeed conceive tissues of the most elaborate character, and new matter of the most wonderful properties and most complex composition, being developed in the most regular and orderly manner without supposing that any governing or controlling power acts upon them all, as it were, from a centre. That the most wonderful order is manifest in the arrangement of the component elementary parts, say, of a growing leaf, must be obvious to every one who has examined it; but I feel confident that as soon as each living particle has been detached from the mass which preceded, it is no longer influenced by the latter, and does not influence neighboring masses. Each may be pressed upon by its neighbors, and press upon them in turn during growth, but there is no reason to suppose that any one determines the composition, governs the motion or regulates the action of others. The nutrient matter is distributed to all by vessels or channels running amongst the several collections. Those elementary parts farthest from the nutrient supply will grow more slowly than those nearest to it, but no formative or constructive or synthetic or analytic influence is exerted by the nutrient fluid upon the living matter, nor by the several elementary parts upon one another. Each is under the influence of the vital power associated with the matter of which it in part consists; and whether each can exist independently if separated from its neighbors, or dies soon after it is detached, depends not upon any influence exerted upon it by these neighbors, but simply upon the inherent capabilities of its own vital power, transmitted to it from the living matter which existed before it, and of which it once formed a part.

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Now as regards the nature of the actual phenomena of living matter which are at present beyond the range of observation, at least two diametrically opposite ideas are entertained.

1. There is the common-place notion that structure exists which will account for the actions which take place, but that the details of this supposed structure are too minute or too delicate to be demonstrated by any

magnifying powers which have yet been constructed. For this idea there is no sufficient justification. It is one of those assumptions in elaborating which the modern materialist is so ingenious. In this way he struggles, and with some success, to postpone for a time the inevitable fall of the system he has endeavored to make popular in spite of the overwhelming evidence of facts against it. Here I must remark that the word "structure" as employed by physicists is used in a sense utterly distinct from that in which we use the word. This is evident enough if we consider what is understood by the "structure" of a crystal and the "structure" of an organ or tissue. * * * * *

2. There is the view supported by myself, and in favor of which I have adduced evidence which I believe to be perfectly convincing, that living matter has no definite structure whatever—that, in fact, its particles, and very probably their constituent atoms, are in a state of very active movement, which renders structure and fixity of arrangement impossible—this active movement being an essential condition of the living state, which latter ceases when the movement comes to a standstill. According to this view the idea of structure as belonging to living matter is inconceivable. * * * * * *

Magnify living matter as we may, nothing can be demonstrated but an extremely delicate, transparent, apparently semi-fluid substance. But observations on some specimens under certain advantages of illumination, and with the aid of the very highest magnifying power that can be brought to bear, favor the conclusion that living matter should be regarded as consisting of infinite numbers of infinitely minute particles, varying much in size, and possibly capable of coalescing, free to move amongst one another, as they exist surrounded by a fluid medium which contains the materials in solution for their nutrition and other substances.

One may transport oneself in imagination into infinite space, amid the never-ceasing vibrations visible and invisible—"The lucid interspace of world and world, where never creeps a cloud, or moves a wind," and may perhaps all but see combined in one mental image, as they ever course through space, suns and worlds and systems. And although at first the mind is almost lost in the contemplation of the infinite physical vastness presented it, it is nevertheless able to seize in some degree a more than shadowy conception of the exactness and regularity of the eternal movements, and to recognize the never-ceasing operation in the material universe of inflexible, unchanging law.

But he who in imagination can succeed in mentally placing himself amid the atoms in the interatomic spaces of a living particle, will be in the very heart as it were of an infinity of a very different order—infinite movement and change affecting infinitely minute particles, so very near to one another that the matter of one may as it were run into that of the other, and the masses divide and subdivide again. Of all this movement and change of particles how very little of what occurs in a portion of matter not more than the one hundred-thousandth of an inch in diameter can be comprised in one mental image? But beyond all this there is the power of prospective change, acting through years it may be, which is somehow associated with the minute particles of living matter, as well as many complex phenomena of which the mind cannot take cognizance as a whole, but must consider, as it were, one by one in several successive pictures. * * * * *

But thought may take us yet further. Gradually passing inwards towards the centre, through vast concentric layers of particles, we arrive at last in imagination near the centre of a particle far too minute to be visible, where the atoms of lifeless mat-

ter first live. As to the actual nature of this wonderful change which occurs, we are, and from a purely physical point of view must remain, in darkness. For it is certain that the new temporary living state is absolutely distinct from the non-living state in which the matter existed but an instant before. Before long this will, I doubt not, be generally admitted by those acquainted with the facts, and not biassed by previous confessions or beliefs. * * * *

All living matter is, I repeat, structureless, and it is to the power rather than to the mere matter we must look for the explanation of the marvellous differences in the beings evolved by different kinds. The similarity of various embryos of different animals has often been alluded to, and it has been said, for example, that at a certain period of development the embryo of man could not be distinguished from that of the dog. That there is a general rough resemblance is perfectly true, but, on the other hand, any one who examined the minute structure of corresponding tissues and organs, would not find the likeness so great as is supposed, while he would be struck with the great number of points of difference. Not one structure could be found in any part of one embryo which did not exhibit peculiarities by which it could be distinguished. It would, therefore, scientifically be more correct to say that the embryos were *not like one another*, than that *they were like*. But any argument based upon the likeness, if it existed, would not help the evolutionist, inasmuch as the "likeness" is far greater at an earlier stage of existence, before any form or structure whatever has appeared. Every living form comes from an equally structureless material, and the forms near one another in the scale are not more like one another than they are like forms far above or far below them. If, for example, the evolutionist would examine embryonic living matter at a very early period of development, he would discover not only that man and dog were not to be distinguished, but that not one form of living matter could be distinguished from any other form in nature; nay, the living matter which might become dog or man could not be identified by any means at our disposal, or distinguished from that which belonged to amœba or plant, and yet it is put forward as a discovery of recent date that certain properties manifested by the tissues of animals also characterize some of those plants.

But after all, the assumed likeness is but a likeness in certain general points, and those who wish us to draw certain conclusions from their statements, ought to be asked to point out how it is that every cell, every tissue of the embryos they regard as being alike or identical, exhibits peculiarities and individual characteristics of its own as regards elementary arrangement, rapidity of formation, rate of growth, duration of existence, and a number of other points. * * *

The facts known to microscopical observers in connection with the act of living of the smallest particle of the simplest forms of living matter, are no more to be accounted for by any of the extravagant crotchets lately advanced as explanations of the facts, than are the general broad phenomena of nature which are under the observation of all. Evolution is a wholly satisfactory explanation only to those whose minds have been trained to submission to evolutional authority, and who have brought themselves to regard things as they have been told they ought to regard them, instead of venturing to use their senses, and reasoning on the facts presented to their observation —and indeed see for themselves with their own eyes, instead of accepting, without ever seeing, what they are told has been seen by eyes which are supposed to be specially privileged to see. * * * * * * * *

In conclusion, let me ask you as

students of nature's processes, whether you have not seen enough to convince you that the revival of the assumption which has been abandoned and reintroduced many times during the last few centuries, that the lifeless is the sole origin of the living —that in fact the non-living and the living are one—is now unjustifiable, and cannot be reasonably entertained. This monstrous fallacy, though taught with the greatest confidence, is based on assumptions, and is supported by arbitrarily selected facts, and by not a few misrepresentations and dogmatic assertions. Whenever any form of this false doctrine has been successfully forced into popularity, it has led to the adoption and propagation of the most grevious errors and grotesque conceits.

EDITORIAL.

—The Editor is now engaged in a systematic examination of articles of food, preliminary to a report upon the subject which is to be made next fall. In the course of this work a number of typical slides will be prepared, and, although it is not intended to place them in the market for sale, if any readers desire to obtain a set of these preparations, they can do so by subscribing immediately. Only a sufficient number to fill orders in advance will be prepared. For prices, see the advertisement on another page.

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Dr. Beale's Address.—We take pleasure in presenting rather a long abstract of this Address, not because we are fully in accord with the position assumed by Dr. Beale, with regard to some of the problems under discussion, but because, in spite of his somewhat dogmatic, and, as it seems to us, at times rather unfair criticisms, we regard him as one of the most able and most conscientious opponents of what he designates the "materialistic tendencies of what is miscalled the *science* of our time." There can be no question, in the minds of those who are familiar with Dr. Beale's observations upon cell-growth,—the phenomena of assimilation, and the production of formed material from living matter—that to him we are indebted for the most rational account of the processes of life, as revealed by careful study with the microscope. It is only when he goes beyond the field of direct observation, and enters the arena of philosophical speculation as an opponent of thet heories, or hypotheses, of evolution and gradual development, that we cannot accept his guidance. Even here his arguments would carry greater weight if they were more tolerant, and if there were less disposition shown to misinterpret the words of those whom he opposes; for this he sometimes does by a too literal rendering of expressions which are intended to be one generally illustrative.

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A New Periodical.—*The Microscope and its Relation to Medicine and Pharmacy* is the name of a bi-monthly journal, edited by Prof. Chas. H Stowell, M. D., and Louisa R. Stowell, M. S., assistant in microscopical botany, in the University of Michigan. The second number has been issued, and it contains several interesting articles, with illustrations. We do not wish to be hypercritical, but this new publication falls below our expectations in several respects. The number before us is not carefully edited, as is strikingly shown by an article which originally came from these pages, but which was copied from a summary published elsewhere, and now appears under the heading, "Carbon and the Germ Theory." We would regard the error as a misprint did not the word "carbon" appear several times instead of the proper word—charbon. It may be owing to our conservative notions, but we cannot approve of the general tone of

the publication. We believe that a scientific magazine, whether it be intended for professional men or for a more general reading public, should always be dignified. Therefore, it is with no little regret that we find the first article on the editorial page headed, "It will do for Babes," while the article itself is written in a familiar, colloquial style, which is, to say the least, inelegant. We have already had too much of that kind of free and easy writing in the microscopical literature of this country, and it is to be hoped *The Microscopist* will not encourage it hereafter, —popularity is too dear if it must be gained at such a price. We would like to see the "Facetiæ" omitted, as having no proper place in such a publication. It is always more pleasant to praise than to condemn, and if the editors will only raise the tone of their paper, we will gladly give it a warmer welcome than we can now conscientiously extend.

NOTES.

—We regret that at the time of going to press no definite announcement of the work to be done at the meeting of the American Society of Microscopists, to be held next month at Columbus, O., has reached us. Those who desire particulars regarding the meeting can obtain them from Prof. A. H. Tuttle, of that place.

—The Rochester Microscopical Society, which was organized in the year 1879, has changed its name, and is now known as the Rochester Academy of Science. On the 20th of June a reception was given, which, judging from the program, must have been very entertaining and instructive. The Academy numbers about one hundred and fifty members and seems to be active and prosperous. The "Catalogue of Exhibits" is published in a very neat pamphlet of thirty-two pages, including the articles of incorporation and the constitution and bylaws.

—The legacy left by the late Mr. F. A. Nobert, to the microscopists of the future, to test their skill and also the excellence of their objectives, is a plate ruled with twenty bands of lines, the tenth band of which corresponds to the nineteenth of his former plates. The tenth band of the new plate, therefore, has about 112,000 lines to the English inch. The last band has 20,000 lines to the Paris line, or about 223,180 to the English inch.

MICROSCOPICAL SOCIETIES.

FAIRFIELD, IOWA.

This club held its meeting at the residence of Professor McCalla, April 22d. Prof. McCalla read an interesting paper on the "The Laws of Light and their relation to Microscopy." The subject was handled in a clear and comprehensive manner, finely illustrated by figures and drawings. The arrangement of lenses in the microscope was explained and was especially instructive to the club. After some questions, and discussion of the subject, the club spent the remainder of the evening in examining the various objects of wonder and interest, with the aid of several microscopes in position.

D. H. Worthington, M. D., Sec.

BALTIMORE, MD.

This Society was organized on the 23d of March. A most interesting reception was held at the rooms of the Maryland Academy of Science, on Tuesday evening, May 17th. The hall was crowded. The display was novel for Baltimore, being the first that has ever been attempted there. There were on exhibition about fifty instruments, and each exhibitor showed numerous objects, as follows: Mr. Lugger showed the different forms of life in drinking water which had stood in a glass for three days, and a section of the stem of a plant; Dr. J. G. Morris showed quinate of quinine under the polariscope, and feathers from a butterfly's wing; Professor P. R. Uhler showed the sting of a wasp and other parts of insects; Mr. G. L. Smith showed double-stained sections of plants, also *Daphnia pulex* from Baltimore hydrant water and some parts of insects; Dr. Sternberg, United States Army, showed, with a remarkably fine stand, *Protococcus;* Mr. F. W. McAllister had fourteen instruments, showing a great variety of objects; G. T. Sadtler & Sons exhibited twenty microscopes, including two of Beck's largest binoculars, and some of the objects were very much admired; Dr. Edward M. Shaeffer

showed pollen and anthers of flowers; Dr. Alan P. Smith showed the wing of a butterfly; Dr. Christopher Johnston showed quinate of quinine and other objects; Dr. H. Fröhling showed the tongue of a cat containing trichinæ; Dr. Louis M. Eastman showed a cancer of the breast, also trichinæ in human muscle and in pork; Mr. Octavius Oudesleys showed scales of a moth; Mr. G. L. Spies showed a very beautiful section of an echinus-spine.

IOWA MEDICAL SOCIETY (MICROSCOPICAL SECTION).

The Microscopical Section of the Iowa State Medical Society met in the city of Dubuque, on May 25th.

The President, Prof. J. J. M. Angear, delivered an extemporaneous address on the use of the microscope, showing that the microscope is one of the numerous instruments which medical men use to aid their senses—to carry their investigations further than they could without it. The scientific medical man could get along without the stethoscope or the speculum as well as without the microscope.

To indicate its value in research, he stated that if we were to blot out all knowledge which has come to us through the microscope, we should know no more of cell-life and its wonder-working power than the Hottentot does of the calculus. Take away our knowledge of ciliated, epithelial, glandular and nerve-cells, on what would histology then rest? The present medical science could not exist but for the revelations of the microscope. What should we know of a nerve-axis, cylinder or neurilemma? The beauties of a muscle—its fibrillæ and sarcolemma—would be utterly unknown to us.

Without the microscope the blood appears to be simply a colored, homogeneous fluid.

The microscope, in the hands of the skillful, aids materially in bringing criminals to the bar of justice, and vindicates and clears the innocent.

Some of the appearances of blood-corpuscles were illustrated by drawings on the black-board, as was also Dr. Piper's method of diagnosing human blood. In all such cases the blood-corpuscles, and not the micromillimetre, should be taken as the unit of measurement.

If the corpuscle does shrink, as some claim, by drying, that is to the prisoner's advantage, and he cannot complain. The conscientious microscopist can rest assured that if he errs on account of the contraction of the corpuscles, he errs on the side of mercy. Dr. Wm. M. Eames, being anxious to test whether human blood can be identified in stains, sent Prof. J. E. Smith some stains, marked alphabetically—some of them of human blood and some not—requesting him to examine, and tell, if possible, which were human. Prof. Smith used a power of 4,000 diameters and camera lucida, drawing the corpuscles on paper. When he had concluded his examination, he went before a notary public and swore that the specimens marked "F" and "I" were human blood, and forwarded the same to Dr. Eames. Dr. Eames then wrote to Prof. Smith: "Your report of the examination of specimens of blood-stains I sent you is received. Much to my surprise you have made no mistake in regard to any of the nine specimens submitted. The two marked "F" and "I" are, as you pronounced them, human blood."

The doctor closed by giving some illustrations on the black-board, and making some remarks on the detection of forgery by the microscope.

A number of microscopes with anatomical slides were on the tables during the entire session of the Medical Society.

Dr. McIntosh, of Chicago, interested the Society for an hour, on the morning of the second day, with his improved solar microscope.

Prof. J. J. M. Angear, of Fort Madison, was reëlected President, and Prof. W. D. Middleton, of Davenport, was reëlected Secretary.

The Section adjourned to meet at Des Moines, the last Wednesday in January, 1882, at which time and place the Iowa State Medical Society meets.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—Human Muscle with Trichina, in exchange for well-mounted slides of vegetable drugs.
OTTO A. WALL, M. D.,
1027 St. Ange Ave., St. Louis, Mo.

Living *Volvox globator*, in any quantity, for mounted Algæ or other slides.
J. M. ADAMS, Watertown, N. Y.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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The American Society of Microscopists.

SUMMARY OF PROCEEDINGS.

The fourth annual meeting of the American Society of Microscopists was held at Columbus, O., beginning at ten o'clock Tuesday morning, August 9th, in the room of the Board of Trade. Prof. H. L. Smith, the retiring President, called the meeting to order, and introduced the Vice-President, Dr. George E. Blackham, the President, Mr. J. D. Hyatt, being detained at home by the death of a relative. Ex-President Orton, of the State University, delivered an address of welcome, to which Dr. Blackham responded. A number of new members were elected, and after the transaction of some miscellaneous business the meeting was adjourned until the afternoon.

At the afternoon session Mr. C. M. Vorce read an article, entitled "The Wholesale Destruction of Acari by a Fungus," and another on "Forms Observed in Water from Lake Erie," a subject to which he has given much attention, as most of our readers well know. Prof. A. H. Tuttle then read an article "On the Occurrence of Gregarina in the American Lobster." Methods of work were then informally discussed.

Second Day.—The proceedings of the second day opened at half-past nine o'clock. The minutes were approved and some new members were elected. Mr. Frank Crisp, F. R. M. S., of London, Mr. Charles A. Spencer, of Geneva, and Mr. J. Sullivant, of Columbus, O., were nominated as honorary members.

The following gentlemen were elected members of the Nominating Committee: Prof. H. L. Smith, E. H. Griffith, Edward Bausch, D. N. Kinsman, W. Humphrey, W. H. Bulloch, Rev. A. B. Hervey.

The following articles were read: "Cancer of the Left Auricle," by Dr. Kinsman; Binocular Vision, by George E. Fell. Some by-laws were passed relative to the disposition of papers read before the Society.

In the afternoon Prof. Lester Curtis gave an account of his recent studies of blood, and Dr. Jacob Redding read an article on "Muscular Contractility," embodying the results of original observations and study, which have led the author to form an hypothesis of his own concerning the phenomena of muscular contraction. Dr. E. L. Shurly described "A New Gas Slide."

After the reading of the papers the subject of "Binocular Microscopes" was taken up for informal discussion. Prof. H. L. Smith stated at length his opinions of various forms of binoculars. The discussion was participated in by Messrs. Fell, Newcomer, Up de Graff and others, after which the Society adjourned to meet at ten o'clock the next morning.

In the evening a public exhibition was given in the City Hall. About fifty-five instruments were on exhibition. In the collection there were some very fine instruments, displayed by the manufacturers and dealers.

Third Day.—A number of new members were elected, among them

Miss Sophia Howard, M. D., of Fairport, N. Y., who is the third female member of the Society.

The election of officers for the next meeting resulted as follws: President, George E. Blackham, M. D., of Dunkirk, N. Y.; Vice-Presidents, Lester Curtis, M. D., Chicago, Ill.; T. H. Up de Graff, M. D., Elmira, N. Y.; Secretary, Prof. D. S. Kellicott, of Buffalo, N. Y.; Executive Committee: E. H. Griffith, of Fairport, N. Y.; Robert Dayton, M. D., of Cleveland, O.; Prof. Albert McCalla, of Fairfield, Iowa.

Dr. Blackham accepted the tender of the Presidency in a brief and appropriate speech.

The reading of papers according to the following programme was then resumed: "On the Inervation of the Lung," by Dr. A. M. Bleile, of Columbus, O. "Notes on Lerneocera Tortua," by D. S. Kellicott, ofBuffalo, N. Y. "Should Homogeneous Immersion Objectives be Made Ajustable or Non-adjustable?" by Dr. George E. Blackham, of Dunkirk, N. Y.

The afternoon session was devoted to miscellaneous business and the informal discussion of methods of work.

Mr. E. H. Griffith moved a vote of thanks to the Rochester Academy of Sciences for the invitation to that city for the next session, and expressed the hope that at some future time the Society may enjoy their hospitality.

An informal invitation was presented by Mr. Bulloch, in behalf of the Illinois State Microscopical Society, asking the American Society to hold the session of 1883 in Chicago.

On motion, the Committee on Eyepieces was continued, with the addition of President Blackham, and instructed to report next year.

Mr. E. H. Griffith, renewed his offer of a prize to be given to the best paper on the adulteration of some article of food or medicine, as detected by the microscope.

The Treasurer's report was then read, showing a balance of over $500 in the treasury. It was approved and accepted.

The Society proceeded to the informal discussion of instruments and apparatus, at the close of which it adjourned to meet in Elmira, N. Y., in August, 1882.

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Notes on Microscopical Technology.

BY C. E. HANAMAN.

(*Continued.*)

For a number of years (see *American Naturalist*, Vol. XII, pp. 573 and 574) I have been in the habit of keeping upon my work-table one or more grooved blocks, like that shown in Fig. 27, in which cover-glasses, that

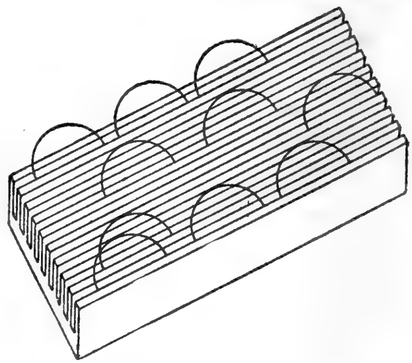

FIG. 27.

have been selected for immediate use, are supported on their edges, and from which they can easily be taken by the forceps. By the use of these blocks it is possible to avoid the evil thoughts which are apt to arise in one's mind, when, having cleaned a number of covers, preparatory to mounting, and leaned them against various convenient but unsuitable supports, it is found that some of them have slid down on the table and are soiled, or have been accidently broken, when the preparations are ready to receive them.

I have also found it convenient, when a lot of covers have been cleaned, to keep them in drawers or boxes filled with narrow strips of new, white blotting-paper, between which the covers are placed on edge, as

shown in Fig. 28. This method of keeping cover-glasses not only preserves them from breakage, and en-

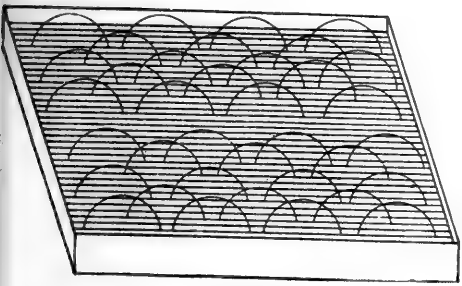

FIG. 28.

ables one to readily pick them out when wanted for use, but also enables one to select for special preparations those of the most desirable thickness. For, by holding the drawer or box between the eye and the source of light, it is easy, by comparison, to select the thickest or thinnest cover, and thus, for all practical purposes, to do away with the trouble of measuring them.

And now a few words on the subject of a quick and simple method of centering mounts, and of cementing the cover-glass. Every one will admit that a neatly mounted preparation, perfectly centered on the slide, is preferable to one mounted in a slovenly manner. Many students, however, feel that time is too precious to waste in what seems unnecessary labor, so long as the preparation is good, and shows the structure to best advantage. While I admit that the beautiful and instructive preparations of some of the greatest histologists are often rudely mounted, I insist that this untidy appearance is no merit, and that the preservation of the object would be made much more certain if a little more attention were given to the cementing of the cover-glass. The use of circular covers and a self-centering turn-table renders it possible to make the wall of cement around the edge of the cover much more perfect than can possibly be done in any other way.

The hints to be given here are to enable the student to save time in this kind of work, and yet produce results equal to the slower and more tedious methods usually employed.

First, let me say a word about cements. In an experience of more than twelve years, during which I have used nearly every kind of cement that has been suggested in the journals and books, published in England and America, I have arrived at the conclusion that two, or at most three, cements are capable of insuring the preservation of an object in any medium the microscopist will find it necessary to employ. These are gold-size (Windsor & Newton's), the ordinary dammar mounting medium, and possibly, for occasional use, the dammar medium to which a small proportion of a solution of rubber in naphtha has been added. Dr. Seiler and others have directed the student to apply his cements in several coats, using great care in holding the brush, and as to the quantity of cement in the brush. I have for several years saved myself much of the time required by such methods of manipulation, by putting on the cement in a broad band over the junction of the cover with the slide, and then, spinning the turn-table as rapidly as possible, running the cement into a narrow band, in its proper place, by holding a knife-blade first on the slide and then on the cover, in such a manner as to cause the cement, spread out by the brush, to heap itself up into a narrow but perfect ring. One coating of cement thus put on is equal to three or four coats by the other method, while the polish of the ring far surpasses in perfection the brush-made ring. If it is desired to color the ring, instead of using anilin mixed with the cement, I recommend the use of the more transparent of the water-colors, such as the student will need to have by him for the purpose of coloring his drawings. The manner of their application is this: after the dried balsam or dammar has been

thoroughly cleaned from the slide and cover, the preparation is placed on the turn-table and a narrow ring of the water-color applied. This will dry quickly and look somewhat opaque. The dammar cement is then put on over the colored ring as above directed, and it will be found that the result is equal in beauty to the celebrated shellac and anilin rings of Mr. Merriman, without the danger of the colors running in, as they often will do when anilin or any color soluble in the cement is used. When glycerin or aqueous fluids are used, it is necessary to apply the dammar alone for a first coat; the water-color being applied over this, and a final coat of gold-size or rubber cement over all. Windsor & Newton put up water-colors in little vials ready for use, under the name of "liquid water colors," by the use of which the student may save himself the trouble of rubbing down the cake. The porcelain ring, so much admired by some, may be obtained by the use of white water-color, or a little white zinc rubbed up with gum-water, and applied as above directed.

The centering of the cover may be quickly and accurately accomplished in the following manner. The slide is placed in the jaws of the self-centering turn-table, a very narrow ring of water-color is made upon its surface with a finely pointed brush exactly the size of the cover-glass to be used. This will dry very quickly; if a number of slides are done at one time, the first will be dry by the time the third is done. The colored ring being insoluble in any but watery mediums, the object may be arranged on the slide in alcohol, oil of cloves, carbolic acid, balsam or dammar, and it will be easy to see when the edge of the cover exactly coincides with the edge of the colored ring.

This ring will show through the transparent ring used for finishing, provided it be not covered by a broader ring of color before the finishing ring of cement is applied, as suggested above. In any case it does not detract from the appearance of the slide.

When mounting in glycerin or watery fluids, it is always advisable to use a cell of some kind, even though it be no more than the shallowest cement cell, so that the cell, if properly centered, is a guide for centering the cover. From the fact that the glass slides are not perfect rectangles, it is necessary to place the same corners in the same clutches of the self-centering turn-table every time a slide is manipulated on the table. The simplest way to do this is to mark one of the clutches with a cross, and similarly to mark with a file or writing diamond one corner of each slide while cleaning it.

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Beck's "Ideal" Microscope Stand.

The general design of this new stand is the same as that of the well-known "Economic," by the same makers, with such alterations and additions as the requirements of the most advanced workers call for. The instrument is wholly of brass, of excellent workmanship and finish, fifteen inches in height, with the standard length of tube; the latter being telescopic, the stand may be shortened to eleven inches, a most convenient height when the instrument is used in the upright position. The base is a broad, heavy and perfectly steady tripod, from which rises a stout column, to which the body is hinged so as to allow of its being inclined to any angle, with a stop at the horizontal position. The body is of the full standard size, using the same eye-pieces as those furnished with the "National" stands, and furnished with an adapter, whereby objectives with either the society screw may be used, or those with the new broad gauge or "Butterfield" screw, at will. The coarse adjustment is made by a rack and pinion of exquisite smoothness, with sufficient length to

permit the focussing of a three-inch objective. The fine adjustment is by a very delicate spring movement, controlled by a large milled head at the rear of the body, most conveniently placed for the hand.

The stage-ring or platform, is made of very thin but stiff brass, with a large, central opening, and is provided

FIG. 29.

with removable and reversible spring clips, exceedingly delicate, and adapted to any thickness of slide. By these a slide may be clamped on either the upper or the lower side of the stage and manipulated with the great-

est ease, permitting the employment of the utmost obliquity of illumination. In addition to this stage-ring or platform, two additions are furnished as desired by purchasers. In the first and cheaper, a circular stage-plate of thin sheet-brass is provided, which revolves concentrically upon the stage-plate ; in the second, a glass stage with a stop for a Maltwood finder, and movements of over one inch in all directions is furnished, and this is the one delineated in the illustration, which shows the glass stage removed.

The double mirror and substage are attached to a stout triangular bar, which swings above the upper stage on either side, upon a graduated circle, with a centering stop in the optic axis. Both mirror and substage slide upon this bar to any position required, or they can be entirely removed and employed separately or combined, as may be desired. The substage ring is of the standard size, carrying any of the usual accessories, such as paraboloid, polariscope, achromatic condenser, dark-well and Woodward's prism, and is so arranged that the polariscope and achromatic condenser may be used in combination, to the great increase in the brilliancy of the former.

The mirror swinging above the stage may be used as an illuminator for opaque objects, but a condensing lens for this purpose is also provided. Both the circular and the glass stages are fitted for carrying a pair of stage-forceps ; the diaphragms have openings of various sizes which may be placed in immediate contact with the under surface of a slide if desired, and no pains have been spared to provide for all the wants of the working microscopist, in every department of science, in this one stand, which is believed to be at least unexcelled by any other of its class.

The illustration and foregoing description relate to the "ideal" microscope in its monocular form. It is also made binocular, with the glass stage, substantially as described.

The Bee's Tongue and Glands Connected with it.*

BY JUSTIN SPAULDING.

The present paper is the outcome of an interest in the subject, awakened by an article, by Mr. J. D. Hyatt, on the sting of the honey bee, in the *American Quarterly Microscopical Journal* for October, 1878, followed by one on the structure of the tongue by the same author in July, 1879. Both bear the impress of careful and painstaking interpretation of facts, and a genius in manipulation that is truly marvellous. Mr. Chamber's article, published previously to Mr. Hyatt's, and which he criticises, I have not seen, and am indebted to Mr. Hyatt for what knowledge I possess of it. His article on the bee's sting incited me to attempt to demonstrate for myself if it was indeed the marvellous little structure described, and I can add my testimony to the literal acuracy of description, drawing and, as I believe, of his interpretation of the bee's manner of working it.

My own observation, so far as the ligula is concerned, agrees with Prof. Cook's (see *Naturalist*, April, 1880), and I think he has given the true solution when he says it consists of a sheath, slit below, within which is the grooved rod, and, projecting from the edges of the latter to the edges of the sheath, is a thin membrane, forming, as will be easily understood, when the rod is extended or thrown down, an enclosed sac, open only at the top.

In going over the work of Mr. Hyatt, while examining a mounted specimen of mouth parts, my friend Mr. F. B. Doten, pointed out in the mentum, a small spiral tube that gave me a clue, which, followed up, has resulted, as I believe, in a slight addi-

* Abstract from the *American Naturalist*, with additions.

tion to our knowledge of the parts.

Running the scalpel from the base of one mandible back, across, close to the neck and forward to the other mandible, remove the brain and salivary glands; cut the œsophagus as far forward as possible, turn it back, and if all has been done carefully, one sees coming from the thorax the spiral ducts of two glands, which will be found, on following back, lying one on each side of the œsophagus, in the space between the muscles of the wings.

At the base, the duct enlarges into quite a reservoir. The ducts unite within the neck, or just as they enter the head, and, following the floor of the latter, are joined by a pair coming in right and left. Following up one of these side glands, we find it dividing into three main branches, ultimately terminating in glands; the glands from the thorax bear a striking resemblance to the Malpighian tubules of insects, while those from the head are larger, different in shape and composed of much smaller cells. Keeping to the floor of the head, the main duct passes on to the sub-mentum. Here, on joining the spiral tube coming from the ligula, it passes by an opening common to both into the mouth. Below the opening the spiral tube dips into the mentum and is imbedded in its muscles.

A series of cross sections shows it to gradually widen to near the base of the ligula, where it terminates in a chamber that leads above into the sac, and below by a valvular opening into the groove in the rod.

Thus we have a passage from the tip of the ligula through the groove in the rod, and the spiral tube in the mentum to the opening in front of the pharynx, above the labium and between the mandibles. This opening is transverse, and seems to have lips, and from its appearance we should expect it to close like a valve, if suction was applied below.

Meeting this tube from the ligula, and discharging its contents through the same opening into the mouth, is the spiral duct from the glands of the head and thorax.

The questions are at once thrust upon us, whence comes this structure? and of what use is it to the bee? If I were wise the article would end here; but our inclination to explain everything by resorting to speculation, is always strong, in the absence of facts to curb it. It seems but natural from the size, position and outlet of the glands, connected as they are with an inlet for the nectar of flowers, to conclude that they are organs that furnish the animal secretion that changes nectar into honey, and I would venture the suggestion that they may be the spinning glands of the larvæ modified. If this is true, I should expect to find them either in an active or aborted condition in nearly all Hymenoptera.

Another question raised is, in what way is nectar carried from the flower to the mouth? This must be, from the nature of the case, largely a matter of speculation. Prof. Cook, in his article, says: "The tongue is also retracted and extended rythmically while the bee is sipping." May not this motion be due to a pumping action of the grooved rod of the ligula, that enlarges and diminishes the size of the sac lying behind it? It would seem that the bee has perfect control of this rod, that it is remarkably elastic, and capable of much extension and contraction; the rod and sac thus acting as a suction and force pump, as will be easily understood by one familiar with the parts.

Of course I cannot say that the bee makes this use of it, but I do say it should, and if it does not, it is pure stupidity on its part. And if some one demonstrates that I am all wrong now, evolution at no distant day will set me right, for there will be born a bee, less conservative, that will dare defy old usages, and take a new departure; that bee, trust me, will make use of this cunningly-devised apparatus, and produce honey cheaper than

any competitor, excepting the glucose man, and I hope and trust may worry even him.

[Many celebrated entomologists, especially Europeans, assert that the tongue of the bee is solid and essentially a "lapping" organ. Others, with equal confidence, pronounce it a "hollow sucking tube." Whatever may be the true construction of the tongue, one fact is certain and easy of demonstration, viz.: bees both suck and lap their food. To show this, first attract the bees by exposing some honey in an open vessel, and, having secured their attention, remove the dish, and substitute in its place a pane of glass with a single small drop of honey upon it. Invert the glass so as to observe the bees from the upper side. At first they will be seen to insert the ends of their tongues into the drop, and suck with the pulsating motion of abdomen and tongue referred to by Cook (p. 118). Then, as soon as the supply of honey is so far exhausted that sucking is impracticable, they may be readily seen to lap up the remainder, whipping their long tongues, fully extended, over the glass until every particle of it is secured.

In Mr. Hyatt's article in the *Quarterly* he doubts that there is any connecting membrane, but that such a membrane does really exist, may be seen by killing a bee while in the act of sucking, and carefully pressing the thorax when the rod will be thrown out, and the membrane disclosed to the naked eye. Owing to its extreme thinness and delicacy, however, it is next to impossible to show it in a mounted specimen. Mr. Folsom's section was made from the tongue of a bee which died naturally with the rod out, and required no manipulation.—JOHN D. WHITE.]

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Bacillus Anthracis.

BY GEO. M. STERNBERG, SURGEON U. S. ARMY.

The excellent articles, by D. E. Salomon, D. V. M., in the April and May numbers of the MICROSCOPICAL JOURNAL, have made your readers familiar with the nature of the evidence upon which the claim is based that the disease known as anthrax, or splenic fever (charbon of the French, Miltzbrand of the Germans) is due to the presence, and multiplication in the body of an infected animal, of a minute vegetable parasite, the *Bacillus anthracis*.

Those papers will serve admirably as an introduction to the brief account, which I propose to give here, of a few experiments recently made.

Not long ago Prof. J. Newell Martin, of Johns Hopkins University, kindly placed in my hands a small tube just received by him from Dr. Burden Sanderson, of London, together with a letter from Burden Sanderson, in which that gentleman says: "I send you the material I started from in the last experiments that I made on the subject" (anthrax). "It was then five years old and consequently is now seven or eight. I have no doubt that you will find that if worked up with salt-solution and injected into a mouse, you will have the spleen—after from twenty-four to twenty-six hours—enlarged and infiltrated with Bacillus."

Soon after receiving this material, I captured a mouse (June 4th) and opened the tube (which did not contain more than $\frac{1}{4}$ to $\frac{1}{10}$ of a grain of dried blood), rubbed up the enclosed material with a little salt-solution, and injected a few minims of this, with a hypodermic syringe, beneath the skin of the little animal.

In accordance with Burden Sanderson's prediction, the mouse died in a little less than thirty-six hours; and upon examing its spleen, an abundance of rods were found, exactly resembling *Bacillus anthracis*, as shown in Koch's photographs from the spleen of a mouse (Cohn's *Beiträge*, Band II, Taf. XVI, Fig. 5). A portion of the spleen was placed in a culture-cell with a few drops of sterlized chicken-*bouillon* and kept for

twenty-four hours in a culture-oven at a temperature of 100° Fah. The following day the culture-fluid was found to contain a luxuriant growth of filaments, many of which contained shining, oval spores, resembling the figures of Cohn (*Beiträge*, Band II, Taf. XI) and the photographs of Koch (*l. c.*, Taf. XVI, Fig. 3), in which they show the results of the cultivation of *B. anthracis* for twenty-four hours in aqueous humour.

A fragment of the spleen of the mouse was used to inoculate a small quantity of blood from a healthy rabbit, drawn directly from a vein into a sterilized tube. The anthrax-bacillus multiplied abundantly in this blood, growing into long filaments and forming spores as in the culture in chicken-*bouillon*. On the 13th two minims of this blood-culture were injected into a small rabbit and a still smaller quantity into another mouse. The mouse died on the following day and the rabbit on the 16th. Upon post-mortem examination an abundance of bacilli were found in the blood, liver and spleen of both of these animals. The mouse was found upon the point of death, but still living, on the 14th, and was killed by crushing its skull. The blood and liver, immediately examined, gave the result above stated.

I have not pursued these experiments any further, as my only object was to get a fresh stock of anthrax-virus and the material from which to make some photo-micrographs of *Bacillus anthracis*

The researches of Davaine, Koch, Cohn, Pasteur, Greenfield and others seem to me quite conclusive as to the intimate and essential relation of the *Bacillus* to the etiology of anthrax, and further confirmation scarcely seems necessary. Moreover, my time is fully occupied by other experimental researches. I shall take this opportunity however for making a few remarks upon the staining of bacteria for the purpose of making photo-micrographs of them.

The method of staining with sulphuric acid and iodine solution, described in this JOURNAL a short time ago, has given very satisfactory results when the organism has a distinct cell-wall; but since writing the note referred to, my experience has led me to think that a stronger solution of iodine (2–5 per cent.) is perhaps quite as efficient, without the acid (for extemporaneous preparations to be photographed at once); and I am also inclined to believe that the iodine possesses no special advantages over anilin brown, which was recommended by Koch, but which I have only recently tried, not having had a supply of the material. I secured a half-ounce a few days since and have now a sufficient supply for myself and my friends for a long time to come. I find that it dissolves freely in water and stains vegetable protoplasm as deeply as could be desired for the strongest photographic contrast. With my five-cent bottle of violet ink, purchased from the stationer, and the anilin brown, I feel that I am supplied with staining material which, so far as the bacteria are concerned, leaves nothing to be desired. I do not, however, expect to discard the iodine solution, which has done me good service, but I recommend it rather without than with the sulphuric acid, as directed in my previous note.

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Preservative solutions for Botanical Preparations.

In an opuscle published in 1872 by Messrs. Cornu, Grönland and Rivet, but now very rare, a number of useful formulæ for preservatives are given which the Editor of *Brebissonia* has reprinted. We give them here without comment, merely indicating the purposes for which each solution is specially applicable:—

1.	Pure glycerin........	1	volume
	Alcohol.............	1	"
	Camphor-water	1	"

For preserving vegetable tissues generally, epiderms, sections of leaves, woody and fibrous tissues. This may be used either as a medium for mounting in cells, or to preserve specimens in bottles. It renders very delicate tissues such as young cells too transparent.

2. Glycerin............3 volumes
   Camphor-water,..... 2 "

For the same purpose as No. 1, but only to be used in closed cells.

3. Distilled water....100 grammes
   Cloroform....... 2 "

Shake vigorously. An excess of chloroform will settle to the bottom and thus maintain the solution saturated. This liquid is useful for all tissues in course of development, and therefore tender — prothalli, embryonic sacs, archegones, and reproductive organs of cryptogams in course of formation.

4. Same as No. 3 with the addition of 4–5 grammes of glacial acetic acid.

This is said to preserve confervæ perfectly without contracting the chlorophyll. It is useful for pith, fungi with numerous spores, agarics penicillia, etc., which tend to retain air, because after a time the fluid absorbs the air.

5. Dissolve camphor in a given quantity of chloroform until a saturated solution is obtained. Remove the excess of camphor, and add a quantity of chloroform equal to that first used. Dissolve 4 grammes of the liquid thus obtained in 1 litre of water. This liquid may be used as a substitute for No. 1, and it possesses this advantage that it only slightly contracts the primordial utricle. For very delicate algæ, (*Spirogyra*, *Rhynchonema*, etc.) it is preferable to No. 6.

6. Camphor water.......75 grms.
   Distilled water.......75 "
   Glacial acetic acid.... 1 "

This liquid preserves marvellously well the delicate algæ (*Spirogyra Rhynchonema*, *Zygnema*, etc.) *

9. Distilled water...500 grms.
   Phenate of soda.. 1 "

For vegetable tissues.

Two formulæ have been omitted from the above list because of their limited usefulness.

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Diagnosis of Blood-stains.

Dr. J. G. Richardson, of Philadelphia, gives the following summary of the results of his measurements of blood-corpuscles, published in *Gaillard's Medical Journal*, and reprinted in *The Medical Herald*, from which we copy:—

First—That in unaltered blood-stains, as ordinarily produced by the sprinkling of drops of blood upon clothing, leather, wood, metal, etc., we can, by tinting with anilin or iodine, distinguish human blood-corpuscles from those of the ox, pig, horse, sheep and goat, whenever the question is narrowed down by the circumstances of the case to these limits.

Second—By the method I have devised we can measure the size of the corpuscles, and apply the two corroborative tests of tincture of guaiacum with ozonized ether and of spectrum analysis, to a single particle of blood-clot weighing less than one fifteen-thousandth part of a grain, a quantity barely visible to the naked eye.

Third—Hence, when an ignorant criminal attempts to explain suspicious blood-spots upon his clothing, weapons, etc., by attributing them to the ox, pig, sheep or goat, or to any of the birds used for food, we can, under favorable circumstances *absolutely disprove* his false statement, and materially aid the cause of justice by breaking down his lying defense, even if twenty years have elapsed.

Fourth—But, if the accused person ascribes the tell-tale blood to a dog, an elephant, a capybara, or any other animal in Dr. Woodward's list, it is useless to attempt to dispute his

* See also the modification of this formula on page 75, Vol. II.

story, on microscopical evidence as to the size of the blood-corpuscles.

Fifth—In cases of innocent persons wrongfully accused of murder, and really stained with the blood of an ox, pig, or sheep, testimony of experts, founded upon measurement of the corpuscles, would be valuable, but less conclusive, because, under certain circumstances, human blood-corpuscles may *shrink* to the size of those of the ox, whilst under no known condition do ox or pig corpuscles *expand* to the magnitude of those in human blood.

Sixth— In order to do away with ingenious objections of lawyers that the murdered person may have been affected with some disease which altered the size of his blood disks, or that the articles of clothing, etc., upon which the stains were deposited had produced, chemically or otherwise, some similiar change in their magnitudes, it is very important to obtain, promptly, stains from the fresh blood of the victim, made in the presence of witnesses, upon portions of the prisoner's clothing, or weapons analogous to those upon which suspicious red spots are found when he is arrested. When this cannot be done, spots of the murdered person's blood, sprinkled on white paper, and fragments of his lungs and kidneys, should be carefully preserved, the former by rapid drying and the latter by preservation in diluted alcohol. These little precautions, which may in any instance, prove to be of infinite importance, should be earnestly impressed upon coroners, district attorneys and policemen, throughout the civilized world.

EDITORIAL.

Subscriptions.— Please observe that when the Journal reaches you in a pink wrapper, it is an intimation that your subscription for the current year has not been paid.

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Adulterations.—Only a very few orders have been received for the series of slides which were advertised last month. As a number of our readers may want the set, who have failed to order as yet, we take occasion to remind them that the time for receiving orders is limited to the present month.

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New Micrographic Dictionary. —A new (fourth) edition of the Micrographic Dictionary is announced to be published by John Van Voorst. It is to be issued in monthly parts, costing 2s. 6d. each, of which there will probably be twenty-one in all, containg 53 plates, and more than 800 wood-cuts. Most of the plates have been improved, some new ones added, and many new objects have been figured and described. The editors are J. W. Griffith, M. D., the Rev. M. J. Berkely, M. A., and Prof. T. Rupert Jones. We shall probably have occasion to notice this work more at length in a future issue of the Journal.

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The American Society of Microscopists.— The fourth annual meeting of this Society has just been held, and for the purpose of publishing a summary of the proceedings we have, for the first time, delayed the issue of this Journal several days beyond the 15th of the month.

The enforced absence of President Hyatt was certainly a great disappointment to the members, and it is a matter of sincere regret that he was prevented from delivering the excellent and instructive address which he had prepared for the occasion.

With the meagre information concerning the meeting now in our possession, it would be premature to speak with great assurance as to the importance of the acticles read at Columbus; but we may say with confidence, that some of the articles presented are of considerable scientific

value, and in this respect the Columbus meeting has been more successful than some of the preceding ones. Among the more important contributions to science which were read at Columbus, may be mentioned Mr. Vorce's article on the destruction of Acari by a fungus, and that of Prof. Curtis, on blood; Dr. Jacob Redding's paper on muscular contractility also deserves to be classed among the more important ones.

The attendance at the meeting was not large, but the Treasurer's report showed a balance of $500.00 on hand, which will doubtless enable the Society to publish another volume of Proceedings.

Next year the Society meets at Elmira, where, owing to the activity of the local Society at that place, a large and interesting meeting will doubtless be held.

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LIVING MICROSCOPIC SPECIMENS.—Most of our readers are doubtless aware of the liberal support which the English public has accorded to Mr. Thomas Bolton, in his efforts to supply microscopists with living microscopic organisms. We are pleased to state that Mr. A. D. Balen, of Plainfield, N. J., who is an industrious and enthusiastic collector, is making arrangements whereby he expects soon to be prepared to furnish various kinds of minute animals and plants of a most interesting nature. As soon as Mr. Balen is ready to send specimens by mail, we will again allude to this subject; but those who are interested in the enterprise would do well to correspond with him now, as he has a variety of beautiful objects always at command.

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CLOSE LINES RESOLVED.—Some time ago Dr. S. O. Gleason, of Elmira, N. Y., wrote a letter to the Editor, not for publication however, desiring that inquiry should be made among the readers of this JOURNAL, to learn "what has been done in resolving lines ruled on glass, and the methods by which the most successful results have been attained." He states that, so far as his knowledge extends, no one has claimed to have seen lines closer than 112,000 to an inch, with the simple mirror-illumination; but he now asserts that with a 1/8-inch objective, by Gundlach, a 3/4-inch ocular and the mirror alone, using a low, kerosene lamp for illumination, he has resolved the band of 120,000 lines on Fasholdt's plate, and that Dr. Hulbrook was present and saw the lines! Now, we do not wish to seem unduly sceptical, but really if he would have those lines photographed and then count them, the evidence as to the true number of lines to the inch would be more convincing. At present we do doubt that a true resolution of 120,000 lines to the inch is possible in the manner Dr. Gleason describes.

We take pleasure in starting the inquiry, and we hope to receive communications from many who have given special attention to the resolution of lines on glass.

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A PROCESS OF COLORING INFUSORIA AND ANATOMICAL ELEMENTS DURING LIFE.—M. A. Certes, who is well known to microscopists for his excellent method of fixing infusoria, and mounting them with their organs extended, has lately published an article in the *Comptes Rendus de l'Académie des Sciences*, describing a method of coloring these organisms during life, which we condense as follows:—

It has long been known that infusoria and rhizopods are able to ingest particles of coloring matter held suspended in the water in which they live. Among the ciliated infusoria, the Opalines, the Haptophrya and other parasitic infusoria without a buccal opening, are the only ones which cannot take in particles of carmine or indigo. Colored tinctures may or may not be poisonous to infusoria, but the cells do not become colored until after death. To this

general rule there is one exception. In a weak solution of *quinoléine* blue or cyanin, infusoria become colored of a pale blue, and may continue to live for thirty-six hours. The color concentrates in the fatty granulations of the protoplasm. It is very faint in the sarcode expansions, in vibratile cils, the cuticle and pulsating vacuoles. The nuclei escape even more completely. Hence, it becomes easy to follow the phenomena of the division of the nucleus in the living animal undergoing division. This coloring matter is one of the best reagents for fatty matter. The diverse reactions which it produces in the same cell afford a new proof of the difference in chemical composition of the cellular and nuclear protoplasm. For these experiments an aqueous solution of cyanin should be used, which is very weak, but strong enough. An alcoholic solution fixes the form of many species, like osmic acid. This promises to be a valuable reagent for physiologists and histologists.

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THE MICROSCOPE AND THE EYES.—In the course of some reminiscences of the late Dr. J. B. S. Jackson, Dr. Oliver Wendell Holmes is reported to have used the following words :—

"Dr. Jackson would never meddle with the microscope ; he was always contented with his natural lenses of ten inches of focal distance. And thus, whatever he lost, he escaped one of the not infrequent effects of over-reliance upon the instrument to which we are under infinite obligations, but which is breeding a generation of intellectual myopes as one of its results."

When a man like Dr. Holmes speaks in this way, it is but right that he should explain his meaning and state upon what foundation his assertion rests. Does the proper use of the microscope, even in the more difficult fields of investigation, produce myopia, or any injurious effect whatever, upon the eyes ? If there is evidence to prove that it does so, we would be glad to have Dr. Holmes bring it before our readers. We are loth to believe that he would make the assertion without convincing proof of its accuracy.

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PROTOPLASM AND NUCLEUS.—A number of investigators have lately given their attention to the structure and functions of nuclei, in both animal and vegetal cells. The subject is still very obscure, and there remains considerable difference of opinion as to the relative importance of nuclei. However, the attention that they have received has lately led to many new discoveries. It has been found that many plant-cells, which were supposed to be destitute of nuclei, do possess them—sometimes several in each cell ; but it is stated that the Phycochromaceæ have no nuclei. The following summary of the views of F. Schmitz will prove interesting in this connection : The protoplasm of vegetable cells is a reticulated framework of fine fibrillæ. In the youngest cells the peripheral layers of the protoplasm are freely dotted, while toward the middle are homogeneous lacunæ or vacuoles. These increase, both in number and in size, as the cell grows older, frequently coalesce until the protoplasm becomes reduced to a reticulated, parietal utricle, with a number of threads crossing the cell-cavity. Between the meshes there is a homogeneous fluid. The nucleus consists of a matrix in which, after hardening and coloring, a very fine punctation can be recognized, probably due to a reticulate structure. The nucleus must be regarded as a differentiated portion of the protoplasm ; its special function appears to be the formation of the proteinaceous substance.

We are not yet prepared to subscribe to all that has been written about the reticulated structure of protoplasm and nuclei, but prefer to wait for more convincing demonstrations. Mr. C. Fromman not only finds the reticulated structure in the protoplasm in the chlorophyll-grains and

in the cell-walls, but he also states that adjoining cells usually communicate by means of openings through which the threads of protoplasm pass. This observation is so utterly at variance with previous experience, that we greatly doubt its accuracy, and regard the statement as very improbable. We are particularly cautious about accepting the conclusions concerning the reticulations since Dr. Lester Curtis, of Chicago, thinks he has conclusively proved that the net-work of blood-cells, which Klein and others have so fully described, has no existence in the living cells. Dr. Curtis's article, to which we allude, has not yet been published.

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FAT-CELLS AND THEIR RELATIONS TO BLOOD-VESSELS.—Dr. Wm. R. Weisiger, of Manchester, Va., President of the Richmond Microscopical Society, has kindly favored us with a bound volume containing an article read by him "On the Relations of the Minute Blood-vessels to the Fat-cells in the Fascia of the Calf's Neck," illustrated by eleven photographic prints and three colored plates. The text covers six pages, and is merely a short description of the salient features of the illustrations, including an account of the processes of staining employed. One of these seems to be original and very successful. A portion of the fascia is soaked in a one-half per cent. solution of osmic acid for from half an hour to two hours, then placed in a solution composed of carmine ½ dr., borax 2 dr., water 4 oz. for fifteen minutes, and immediately, without washing, transferred to a saturated solution of picric acid ; then wash quickly and mount in glycerin, acidulated with two drops of formic acid to the ounce. It is not an easy matter to give a satisfactory notice of this book, as the author relies almost entirely upon the plates for his demonstrations. He traces a very intimate connection between the fat-cells and the vessels and, while one cannot say beforehand what particular cells will develop into fat-cells, it is to be observed that "as soon as the slightest approach to the formation of fat in the cells takes place, the nuclei stain intensely blue in hæmatoxylin preparations."

Probably Dr. Weisiger can furnish copies of this book to those who desire them.

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PRELIMINARY CATALOGUE OF THE FLORA OF NEW JERSEY.—This is a valuable contribution from the Geological Survey of New Jersey, compiled by N. L. Britton, with the assistance of eminent botanists. Only one side of each leaf is printed, leaving the opposite page blank. It includes both Phanerogams and Cryptogams.

The lists of Musci and Hepaticæ are compiled from the valuable collections of the late C. F. Austin, the Lichens are from a list compiled in the year 1878 by the same author, the Fungi-list was prepared by Mr. J. B. Ellis, and a provisional list of the Characeæ was furnished by Dr. T. F. Allen ; the Rev. A. B. Hervey compiled the list of Marine Algæ, and Rev. Francis Wolle that of the fresh-water forms. From this brief statement it will readily be understood that the work has been well done, and as the books now distributed among botanists are to be returned to the department at the close of the next season, with additions and suggestions, it is probable that the final catalogue will be very complete.

Botanists can obtain copies by application to the State Geologist, Prof. George H. Cook, at New Brunswick.

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MARINE ALGÆ OF NEW ENGLAND.—Professor W. J. Farlow's report to the U. S. Fish Commission, upon the algæ of New England and the adjacent coasts, has just been reprinted in a pamphlet of over 200 pages, with fifteen plates. It is intended to include all the marine species of algæ, with the exception of the diatoms, at present known to occur on the coast

from New Jersey to Eastport, Maine. The descriptive part is preceded by an account of the structure and classification of sea-weeds, which is clearly written, and shows the work of an experienced student of the algæ. An artificial key to the genera is given, which surely would be of great assistance to any person visiting the seashore, who, desiring to collect and to name algæ, lacks the necessary knowledge of their structure and classification. We are very much pleased with this report, and most heartily commend it to those who wish to begin the study of marine algæ.

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RED SNOW IN COLORADO.—The following newspaper paragraph, which we take from *The New York Times*, indicates that the curious red alga, known as *Protococcus nivalis*—not an animalcule, as asserted below—is not uncommon upon our snow-capped mountains: "In the almost inaccessible defiles of Mount Shasta, in California, is the only other known place in the United States where this is seen. In polar regions it is a familiar sight, and no extensive traveller there returns without a description of it. The broad fields of everlasting snow that flank the northern coast of Greenland are flaked with the strange blood-red, and further toward the poles miles of it stretch as far as the naked eye can reach. The phenomenon is due to the presence of minute, red animaculæ in the snow. A microscope detects its presence, but how it got there is a difficult question, and has never been satisfactorily answered. The red snow in this region is first seen at the head of Cross Creek, where it may be observed in patches of intense carmine, varying in area from as large as a man's hat to 20 feet in diameter. Taken in the hand and closely examined, nothing can be detected that gives it color, and it melts into clear, red water, leaving no stain. Further on, in some of the steep gulches with which the country abounds, the bottoms are entirely covered with the strange substance. In some places the color is vivid in the extreme, while in others it fades to a faint pink, producing an effect not readily described in words. Still higher, and at the very foot of the mountain, the red snow disappears, and nothing save the pure white coverlet greets the eye."

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AN AFTERNOON ON PASSAIC RIVER.—On the 25th day of last month the Editor, in company with his former colleague on the *Quarterly*, Mr. J. L. Wall, escaped from the city and made a trip to the town of Belleville, on the Passaic River. A row-boat was engaged, and we proceeded to collect specimens from along the shores. Not many species of algæ were found, nor was there any great variety of animal forms, but the water-plants, so hardy and useful in aquaria, the *Anacharis Canadensis* and *Vallisneria spiralis*, were abundant. Reaching over into the shallow water, it was an easy matter to obtain perfect plants of *Vallisneria* with good roots, and we collected a number of them. The *Anacharis* grows so readily without roots that the more fresh looking stems were carried home without regard to the roots. An old can was made use of to carry home some of the river mud, in which to plant the *Vallisneria*. The mud was placed in the bottom of a tall specie jar, the roots of the plant were properly embedded, and the jar filled with water. The next morning, after the water had cleared by settling, the mud was covered with a layer of clean sand, which tends to prevent riling of the water by a slight disturbance. All the leaves of the *Vallisneria* were removed, so that a new growth might start in the aquarium. It is probable that we will thus obtain some vigorous plants of *Vallisneria* for use during the coming winter. The *Anacharis* was simply thrown into a large aquarium, where it will doubtless grow without further care. Rowing about slowly, a long, green, spiral filament

was observed reaching up to the surface of the water. It was two or three feet in length, and bore a peculiar flower at the end. This was the female flower of *Vallisneria*, a very interesting object for study ; it was quite a surprise to us, as the plant does not usually flower so early as July. Looking toward the shore, the water was covered with an innumerable quantity of white specs, which attracted our curiosity. Rowing up to them, we found that they were the male flowers of *Anacharis*. These are very curious flowers. The long, tubular perianth, sometimes two or three inches in length, reaches from the axil of a leaf to the suface of the water, and bears the stamens above. It would easily be mistaken for the flower-stem, but it is really the tubular perianth. These flowers were very abundant, so that the water appeared white with them. The pollen-grains were numerous, and could be seen floating about on the water in little clusters resembling snow-flakes. *Potamogeton* was abundant, in several forms, and the common arrow-plant, so named from the shape of the leaf, *Pontedaria cordata*, which is also good for large aquaria. This plant should be set in a flower-pot, with suitable soil in which to root, and then submerged, either wholly or in part.

Among the algæ, two species of Oscillariaceæ were found quite actively moving *Oscillaria tenius* and *littoralis*, and *Lyngbya majuscula*. The most interesting specimen of all, however, was a species of *Ulothrix*, a very common, filamentous, green algæ, in which the cells are about as long as they are wide. It was interesting because when we examined it, at about seven o'clock the next morning, the process of giving off swarm-spores had just begun. The entire contents of each cell in whole filaments, quickly formed into green, spherical masses, which began to move about in the confined space within the cells ; soon the cell-walls ruptured, and the contents escaped as very active swarm-spores, somewhat elongated in form, and furnished with four long, whip-like appendages, or flagella, by means of which they could swim about. They measured $5.^{\mu}8$ to 8^{μ} (.00022 to .00033-inch in diameter). After a while they become attached to some object, lose their flagella, elongate and subdivide, forming new growths of *Ulothrix*.

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Croton Water in August.—The Croton water which is now supplied to this city possesses no offensive taste or odor, although there is a considerable amount of suspended matter to be collected by filtering it. This is another fact tending to prove that the peculiar odor sometimes observed is caused by certain plants which are not always present, and not by the decomposition of vegetable matter of all kinds. We have lately studied the algæ found in a few filterings, although the list is not complete, it may still be of interest to observers in other cities. In naming the algæ we have been assisted by the Rev. Francis Wolle, who has observed most of the forms here mentioned.

Phycochromophyceæ.

Dictyosphærium Eherenbergii.
Cœlosphærium dubium.
Merismopedia (*glauca ?*)
Oscillaria tenuis.
——— *Froelichii.*
Sphærozyga polysperma (*?*)

Chlorphllophyceæ.

Palmodactylon varium.
Raphidium polymorphum v. *falcatum*
Chlorococcum gigas.
Polyedrium trigonum.
Scenedesmus quadricauda.
——— *obtusus.*
Pediastrum simplex.
——— *biradiatum.*
——— *pertusum.*
Gonium pectorale.
Cosmarium subcrenatum.
——— *tetrophthalmum.*
Staurastrum læve.
——— *Sebaldii.*
——— *gracile.*
Micrasterias truncata.

Spirogyra nitida.
Conferva vulgaris.

Numerous species of Diatoms were found, but not named. The *Staurastrum læve* is stated by Mr. Wolle to be a new species for the United States. *Sphærozyga polysperma* is very abundant if the plant observed belongs to this genus, but we are not yet positive as to its proper name. There is another form which occurs in great abundance, the true position of which we have been unable to determine. *Pediastrum simplex* is regarded as a somewhat rare form, but it is abundant in this vicinity. It is found also in the water supplied to Jersey City, and Mr. Vorce has figured it in his first plate representing the organisms found in the Cleveland water. Among the other organisms observed, but not carefully studied, may be mentioned *Amœba villosa*, *Difflugia globulosa*, *D. Corona*, *Arcella* —— ? *Actinosphærium* —— ? *Ceratium* —— ? *Brachionis conium*, Atwood (see this JOURNAL, Vol. II, p. 102), *Chætonotus* —— ? eggs of rotifers, numerous spicules of sponges.

The Editor would consider it a great favor if correspondents in different cities would send him filterings from their water-supply, from time to time, for comparison. They can be readily collected by attaching a bag of thin cloth to the faucet, and running the water for an hour or so. A large bag, about six inches deep, is preferable to a small one, as the water then flows more freely. The sediment should be washed into a conical glass, allowed to settle, collected in a bit of writing paper, wrapped in moist blotting paper, and the whole enclosed in tin-foil, when it may be sent in an envelope.

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A NEW VIVARIUM. — Mr. J. D. Hardy, in the *Journal of the Quekett Club*, describes a modification of the zoophyte trough which possesses certain advantages over the ordinary form. It consists of two slips of glass, 3 inches by 2 inches, to one of which a rubber or a glass ring of any desired thickness is cemented. A piece is cut out of the ring at the top, about a quarter of an inch wide, through which the water and the organisms to be examined are introduced. The surface of the ring is coated with an adhesive cement, or simply greased, and the other glass slip is applied and held in position by rubber bands. The advantages of this vivarium are several. It can be carried about without danger of losing the enclosed specimen or spilling the water, it can be plunged into a beaker of water in any position and the object will not escape, and it can be readily cleaned.

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AERIAL SPORES. — Because of the prevailing opinion among medical men and microscopists that certain diseases result from the germs, or spores, of minute organisms floating about in the atmosphere, many persons have inferred that all fungoid spores found in the air are inimical to good health. This opinion is not well founded. There are many spores which, at certain seasons, are very abundant and which, so far as we know, are quite harmless in their influences upon the system.

Another erroneous notion is, that the air is always loaded with such germs. The fact is that their number is dependent upon the weather. Sometimes few or none will be found at other times they will be numerous.

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COVER-GLASS.—The *Zeitschrift für Instrumentenkunde* announces that the thin cover-glass, heretofore exclusively manufactured in England, will now be made also in Germany, of equally good quality and considerably cheaper. The process, which has been guarded as a secret in England, has been discovered by Dr. Otto Schott, through his own researches. The manufacture has been undertaken by the firm of Halme & Schott Annen, bei Witten (Westp.)

DIATOMS FROM CHINA.—M. Paul Petit has published a pamphlet of eight pages, with a fine plate (from *Mém. de la Soc. Nat. et Math. de Cherbourg*), describing some very beautiful diatoms collected on oysters from Ning-po and Nimrod Sound, China. Figures are given of *Cocconeis Ningpoensis*, Pet.; *Achnanthes subsessilis*, Ktz.; *Triceratium rostratum*, Pet.; *T. Sinense; Coscinodiscus lineatus* var. *oculatus*, Pet.; *Raphoneis scutellum*, Ehr.; *Cyclotella Sinensis*, Ehr. The diatoms of China are but little known, and good collections from there would be highly prized by all students of these algæ.

CORRESPONDENCE.

TO THE EDITOR:—Will some one who knows kindly inform me as to the best way of catching, and holding for examination under the microscope, such minute animals as the book-mite, etc.? What piece of apparatus is the best to use?

W.

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TO THE EDITOR:—On examining some of the powder known as "Vegetable Sozodont Tooth Powder," I found it to be composed chiefly of diatomaceous material, the forms being in both perfect and fragmentary states. The other constituent seemed to be some flavoring matter, which gives the powder its peculiar taste. Various forms of *Navicula* and *Pinnularia* occur in great abundance. Also small and delicate forms. When mounted in Balsam, the powder makes an interesting object.

I send you a sample herewith.

C. W. G.

PALISADES, N. Y.

NOTES.

—Some time ago a correspondent having seen a preparation by the Editor of this JOURNAL in one of the boxes of the Postal Microscopical Club, showing the nuclei of a species of *Spirogyra* stained of a carmine color, asked how the staining was done. The process is very simple, and gives most excellent results. The plant was first killed by alcohol, and immediately placed in a solution of carmine, in which it remained several hours. The carmine solution must be quite neutral or it will not stain properly. The solution actually employed was a neutral carmine from Messrs. J. W. Queen & Co., which had been permitted to stand uncorked until it became slightly turbid from the escape of ammonia, and the consequent deposition of carmine. After the specimen was well stained the excess of carmine was washed out in water or glycerin. The mounting was done in the ordinary way.

—Dr. Georg Winter, the editor of *Hedwigia*, announces that he hopes to continue the issuing of Rabenhorst's Exsiccatæ, with the concurrence of Mrs. Dr. Rabenhorst, as heretofore. From the present month until April next his residence will be Leipzig, Saxony, Emilienstrasse, 18.

—We desire to call the attention of our readers to the slides of diatoms advertised by M. Delogne. The preparer is well known as a student of the diatoms, and we are assured that whatever he sends out in the way of mounted specimens, will be entirely satisfactory. In his circular M. Delogne says: "It is useless, it seems to me, to insist upon the value of the study of diatoms, these pearls of the water, as Bailey called them; I will only remark here that my collections have been shown to Dr. Van Heurck, who has figured a large number of forms from these collections in the plates of his *Synopsis des Diatomées de Belgique*, now in course of publication." Twenty-five francs (about $5.00) for as many slides of authentically named species is not a high price; and certainly those who have Dr. Van Heurck's work would find the mounted specimens very useful.

—We are indebted to Surgeon J. J. Woodward, U. S. A., for a series of nine most admirable photographs of pseudopolypi from the colon, which were described by him in the January number of the *American Journal of the Medical Sciences*. The photographs are remarkably good, and they indicate great skill in the preparation of the sections, which we believe is characteristic of all the work done under Dr. Woodward's supervision.

—The editor of *Botanical Gazette* states that the pellucid stems of *Pilea pumila* (Richweed) are almost as valua-

ble for demonstrating the structure of plants as the pumpkin vine. "The single row of epidermal cells, the frequent section-views of stomata, the typical collenchyma and under it the cambium, and then about a dozen perfectly top-shaped fibro-vascular bundles, all come out so clearly that even a beginner can demonstrate them with but little difficulty."

—At a recent meeting of the Société Belge de Microscopie, M. Errera stated that the anilin color nigrosine was an excellent reagent for staining nuclei. He showed some sections of vegetable tissues, colored with this substance, in which the nuclei had taken a very pronounced blue coloration, which admirably revealed the details of their structure, while the rest of the cell remained unstained. The sections to be stained are allowed to remain in the aqueous solution of nigrosine for a short time, and are then washed in water until the liquid extracts no more color. They may then be mounted in glycerin, or else passed through alcohol and mounted in balsam or dammar in the usual way.

—On the evening of June 16th, the Camden Microscopical Society held a public reception which was well attended, and undoubtedly proved to be very enjoyable. The members of that Society seem to be very active in prosecuting their studies in the domain of microscopy, and we have noticed that at their receptions they have always had something to show which was not only striking in appearance, but also instructive. Too many of our exhibitions are made up of objects that are purchased, and shown by persons who are quite unable to give an intelligible explanation of them. A little more energy in study and collecting, on the part of members of societies, would do much to remove the very common impression among a large class of persons, that the microscope is of more value as a means of amusement than for scientific work.

—The Elmira Microscopical Society has published its Constitution and By-Laws, with a short history of the Society, extracted from the Secretary's First Annual Report, in a neat, small 16mo pamphlet. The Society has forty-seven active and three honorary members, and is prosperous. The method of work seems to be a very good one. There are eight sections, each under the charge of a leader, and whenever a section has anything of interest to bring before the Society, the President appoints an evening for the consideration of that subject. There are now sections on Algæ, Diatomaceæ, Histology, Entomostraca, Entomology, Crystallography, Cryptogamia and Rhizopoda.

MICROSCOPICAL SOCIETIES.

CENTRAL NEW YORK.

A regular meeting of the above named organization was held on Tuesday evening, June 28th, at the office of Dr. Aberdein, in Syracuse, for the election of officers. The following were elected: President, Geo. K. Collins, Esq.; 1st Vice-president, Alfred Mercer, M. D.; 2d Vice-president, C. E. Slocum, M. D.; Treasurer, Robert A. Aberdein, M. D.; Secretary, A. L. Woodward.

The Society then adjourned until the last Tuesday evening in September.

NOTICES OF BOOKS.

The Botanical Collector's Handbook. By W. Whitman Bailey, B. P., Olney Professor of Natural History (Botany) and Curator of the Herbaria in Brown University, Providence, R. I. Naturalists' Handy Series No. 3. Salem, Mass.: George A. Bates. 1881. (Pp. 140. Price, $1.50.)

This is certainly a valuable book for botanists, especially for those who are not experienced collectors. Although we are not particularly engaged in botanical studies, we have read the greater part of this book with considerable interest and with great benefit. The information is practical and it is concisely given. We think the author is quite right when he states that: "The want of a manual such as exists in other countries, for the guidance of botanical collectors and amateurs, has long been felt in our own." In its preparation he has had the assistance, or advice, of such eminent men as Prof. C. H. Peck, who wrote the chapter on "Collecting and Preserving Fungi," the Rev. Francis Wolle, who furnished some notes on the fresh-water algæ, Profs. D. C. Eaton, W. H. Brewer, E. Tuckerman, Mr. Charles Wright and others. The book contains just the kind of information that the student of botany will find most

useful in the collection and preparation of plants for the herbarium or for future study.

Naturalists are greatly indebted to Mr. Bates for the "Naturalists' Handy Series," which he has undertaken to publish. "Life on the Seashore," which is one of the series, has already received a favorable notice in these columns.

Catalogue of the Phænogamous and Vascular Cryptogamous Plants of Michigan, Indigenous, Naturalized and Adventive. By Chas. F. Wheeler and Erwin F. Smith. Lansing: W. S. George & Co. 1881. (Pamphlet, pp. 105. Price, 50 cents.)

This catalogue was prepared for the Horticultural Society. It seems to have been very carefully prepared. The flora of Michigan, as thus presented, contains 113 families (orders) and 1,634 species, of which 182 belong to the Compositæ. The common, local names of the plants are given in the margin of the pages, besides the botanical names.

A Fatal Form of Septicæmia in the Rabbit Produced by the Subcutaneous Injection of Human Saliva: An Experimental Research by George M. Sternberg, Surgeon, U. S. Army. Reprinted from *National Board of Health Bulletin.* Baltimore: Printed by John Murphy & Co. 1881. (Pamphlet, pp. 22, with heliotype plate.)

Ether Death: a Personal Experience in Four Cases of Death from Anæsthetics. By John H. Roberts, A. M., M. D. Reprinted from the *Philadelphia Medical Times.* (Pamphlet, pp. 12.)

This is a valuable contribution to the subject, and is well worthy of the attention of physicians.

Hip-Joint Disease: Death in Early Stage from Tubercular Meningitis. By De Forrest Willard, M. D., Lecturer on Orthopedic Surgery, University of Pennsylvania. Microscopical Appearances with cuts, by E. O. Shakespeare, M. D. Reprinted from the *Boston Medical and Surgical Journal.* (Pamphlet, pp. 20.)

Microscopy in Medical Practice: its Necessity Demonstrated in the Investigation of Disease. By G. Hermann Merkel, M. D. New York: Albert Metz & Co., Printers. 1881. (Pamphlet, pp. 22.)

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—first-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.
M. A. BOOTH, Longmeadow, Mass.

Wanted—Human Muscle with Trichina, in exchange for well-mounted slides of vegetable drugs.
OTTO A. WALL, M. D.,
1027 St. Ange Ave., St. Louis, Mo.

Living *Volvox globator*, in any quantity, for mounted Algæ or other slides.
J. M. ADAMS, Watertown, N. Y.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Section of Brain, stained, showing Tubercular Meningites; also Carcinoma Cerebri. Please send list.
L. BREWER HALL, M. D., 27 South 16th Street.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoœ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides.*
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

Well-mounted diatoms, in exchange for *any well-mounted slides* or material, etc.
W. H. CURTIS, Haverhill, Mass.

For diatoms *in situ* on Algæ, send mounted slides.
K. M. CUNNINGHAM, Box 874, Mobile, Ala.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Slides of hair of *Tarantula*, very curious; also crystalline deposits from urine, to exchange for well-mounted slides. S. E. STILES, M. D.,
109 Cumberland St., Brooklyn, N. Y.

Fine injected specimens of kidney, tongue and liver, also very fine slides of human tooth, prepared according to the method of Dr. Bödecker, showing the protoplasmic net-work between the dentinal canaliculi, in exchange for first-class histological and pathological slides, or other good specimens.
J. L. WILLIAMS, North Vassalboro, Me.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

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The Detection of Adulteration in Food.

BY C. M. VORCE, F.R.M.S.

IV.—PEPPER.

Next after salt, probably pepper is the most commonly used of the condiments, usually in the shape of black pepper which is the same as white pepper, "only more of it," and therefore the black pepper will be first considered.

To determine of what the genuine pepper berry is composed, and what should be found in genuine ground black pepper, we scrape or rasp into fine powder a dried pepper berry and examine the fragments in turpentine with a 1-inch objective. The scrapings from the outer part are found to be composed of reddish or brown angular cells, irregularly arranged in two or three layers, with a darker central portion, as seen in Plate II, Fig. 1, and many scales of clear, colorless, glass-like plates are seen (Fig. 2), which are fragments of the outer cuticle. Soaking the fragments (Fig. 1) of the outer coat in solution of potash, renders them clearer and of a reddish color, although they still retain a darker, granular, central portion, now shrunken to very small dimensions (Fig. 4), but not entirely disappearing, even after long action of the potash with heat. Within this outer skin of the berry is found a thick layer of pulp-cells, polygonal by pressure, in rows, with numerous larger, dark, round or oblong cells interspersed (Fig. 5). These cells much resemble air-bubbles, but are also found free (Fig. 6 *a*), and by a ¼-inch objective are found to be thick-walled cells containing disks of oil of a faint greenish yellow color (Fig. 6 *b*), and drops of this oil, which is undoubtedly the essential oil of the pepper, are found free among the pulp-cells, where it has exuded from the torn oil-cells, when fragments of the pulp are examined in water. After the action of potash, these oil-bulbs show much thickened cell-walls (Fig. 6 *c*).

Among the fragments of pulp-cells are seen a few bits of tissue of heavy-walled, woody cells, forming a sort of framework (Fig. 7) covered by a very delicate, hyaline cell-membrane, often enclosing a bubble of air (Fig. 7 *a*); most of these fragments have portions of spiral tissue attached (Fig. 7 *b*). When these fragments are of some thickness they appear as in Fig. 8 *a*, caused by the thick border of underlying cells being seen so plainly through the hyaline membrane of the upper layer of cells. An ideal section of these cells and diagram of their arrangement is given in Fig. 8 at *b*. A few fragments of deep red, shell-like substance composed of small angular cells are seen (Fig. 9), and are from the shell or hard coating of the seed. The great bulk of the fragments, when a whole berry has been ground up, will be found to be composed of whitish or clear, long, mostly quadrangular, somewhat cuneate cells (Fig. 10 *a*), most of which are filled with very minute starch-grains (Fig. 10 *b*), which are shown at Fig. 10 *c*, as seen free, and after the addition of iodine, by a ¼-inch objective: among these cells

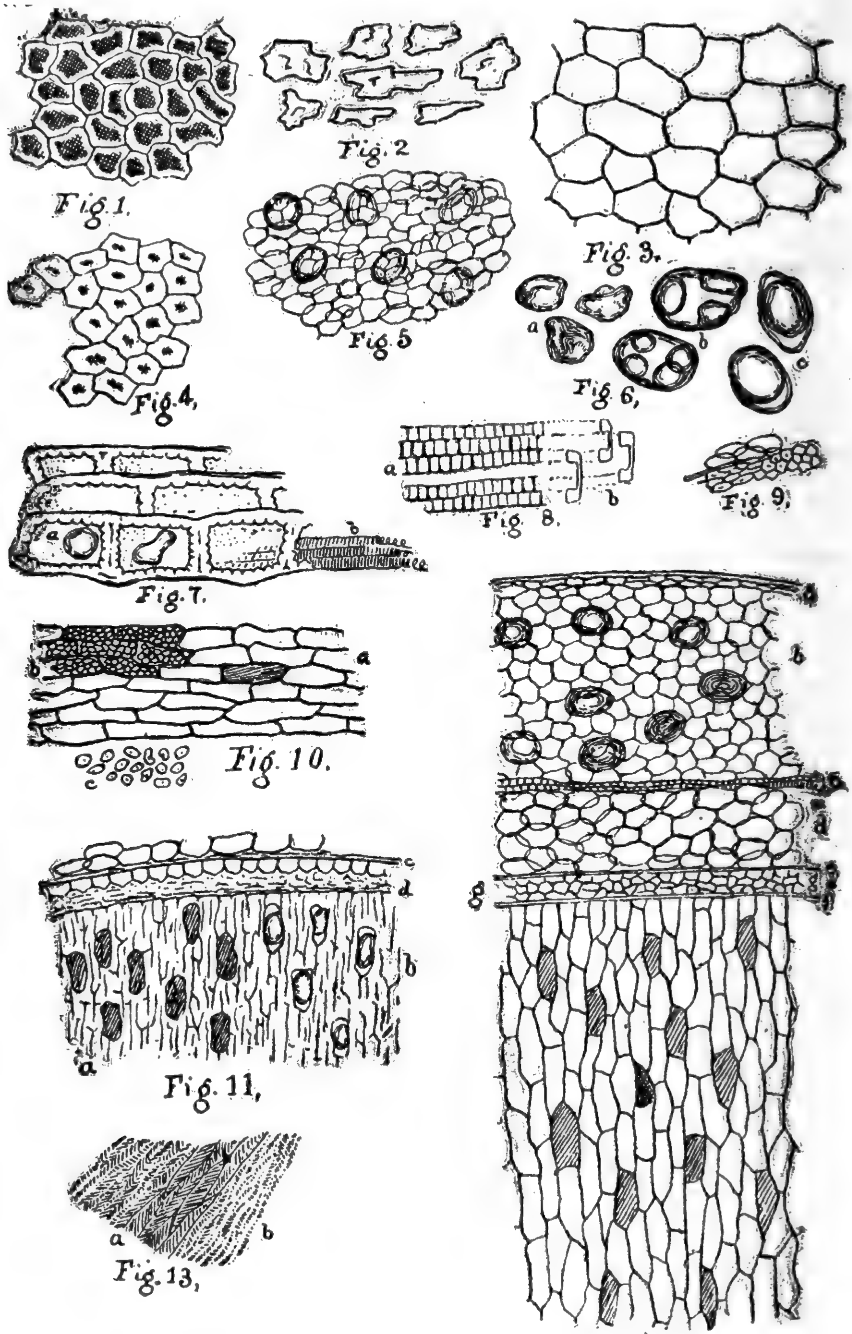
Fig. 1.
Fig. 2
Fig. 3.
Fig. 4,
Fig. 5
Fig. 6,
a
b
c
Fig. 7.
a
b
Fig. 8.
a
b
Fig. 9.
Fig. 10.
a
b
c
Fig. 11,
a
b
c
d
Fig. 12,
a
b
c
d
e
g
Fig. 13,
a
b

Plate II.

are observed others rather darker in color, opaque, and without the starch, but appearing very finely granular and containing, as will be seen, oil in place of starch.

These are all the structures found in some ground pepper berries. In pure ground " white pepper " the epidermal cells and scales (Figs. 1, 2, 3, 4), the pulp-cells and oil-cells (Figs. 5, 6) and the woody and spiral tissues (Figs. 7, 8) should be almost entirely absent, and only the seed-coat and starch-bearing cells (Figs. 9, 10) should be found.

Having learned the structure of the pepper berry, as seen in the ground dry berries, in which condition alone adulteration is to be feared, to determine the proportion of each of the structures found, and their relations to each other, sections of the berry must be cut, for which purpose some are soaked in warm water until they swell and become, although not restored to their natural shape, soft enough to be easily cut. And this takes much more time than would be expected, at least twelve hours being required to soften the berries of good pepper, picked and cured in the proper season. On stripping off the epidermis from a soaked pepper berry and examining it in water and glycerin, with a ¼-inch objective, it is found to be composed of two or three, and in places four or more, layers of angular cells, irregularly arranged (Fig. 3), filled with granular contents and of a pale brownish color, overlaid with a thin, hyaline, structureless, outer membrane. Neither potash or nitric acid materially change the appearance of the cells or their contents otherwise than as to color. By taking a section of a soaked berry we find the pulp to be about half the diameter of the seed in thickness, and in young berries picked before the seed has hardened, often as thick as the seed. Within the outer skin of the berry is a thick layer of pulp-cells with oil-cells interspersed, as in Fig. 5 ; they are somewhat more swollen and rounded than those figured, but otherwise they do not differ in appearance. Next, in a section transverse to the axis of the stem, are seen the ends of the woody cells and spiral vessels (Fig. 7), and in a section parallel to the axis of the stem these are shown in bands, chiefly running from stem to calyx. Within the layer of spiral vessels is another layer of cells not so thick as the layer of pulp-cells (Fig. 5), but composed of larger and more rounded cells, thinner and more transparent than the oil-bulbs of the outer layer,

Description of Plate II.

Fig. 1.—Epidermis of pepper berry, in turpentine, × 73.
" 2.—Fragments of the hyaline cuticle, × 73.
" 3.—Epidermis of soaked berry, in water, × 250.
" 4.—The dry epidermis in potash solution, × 73.
" 5.—Pulp-cells with oil-glands, in turpentine, × 73.
" 6.—Oil-glands, in water, *a* × 73, *b* and *c* × 250.
" 7.—Woody cells and spiral vessels, in water, × 250, *a* air bubbles.
" 8.—Same in several layers, in water, × 73, *a* cells, *b* ideal section.
" 9.—Cells of the hard coat of the seed, × 73.
" 10.—Cells of the seed, with starch, *a* × 73, *b* × 250.
" 11.—Section of seed and shell treated with potash, × 73, *a* oil-cells opaque, *b* same cleared by potash showing oily contents, *c* and *d* outer and inner membranes of seed-shell.
" 12.—Section of seed (one half) in water, × 73, *a* epidermis, *b* pulp-cells and oil-glands, *c* woody and spiral vessels, *d* oil-cells, *e* outer membrane, *f* inner membrane of seed-shell, *g* shell of seed, *h* starch bearing cells of cotyledon with oil-cells.
" 13.—Thin shaving of buckwheat in turpentine, *a* × 250, *b* 73.

and mostly filled with a thinner, oily fluid, probably somewhat diluted by the water in which the berries are soaked, in consequence of the thinner walls of the cells; the water in which the berries were soaked will be found to be a strong infusion of pepper—pepper tea, in fact. These layers form the outer coating, or pulp, surrounding the real seed, which, when divested of the pulp, becomes "white pepper." This seed has a thin outer coat or shell, brittle and horn-like, composed of reddish, angular cells, placed flatwise in two or three layers and with an outer and inner membrane or cuticle (Fig. 11 *c*, *d*). The substance of the seed is wholly composed of the long quadrangular cells (Figs. 10, 12), the greater number of which are filled with starch, and the others, interspersed among the starch-cells, are filled with oil. On applying potash solution to a section of the seed, the starch is seen to quickly dissolve and disappear, and the opaque oil-cells are left suspended amid the now empty starch-cells (Fig. 11); at first the opaque cells are full of extremely fine granular matter—or appear so (Fig. 11 *a*)—but after the potash has acted several minutes, they become transparent, and the contents appear as a drop of reddish oil within the cell (Fig. 11 *b*), and the cells and membrane each side of the seed shell are clearly shown (Fig. 11 *c*, *d*). The relative arrangement and proportion of the elements of the pepper berry are shown in Fig. 12, which is a section from surface to centre of a dried berry restored by soaking.

The most common adulterants of black pepper are the stems of pepper, oil-meal, wheat-flour, corn-cobs, spoiled crackers, and lastly, buckwheat bran, which is said to be largely used for the purpose, and would be impossible to detect except by the microscope. It has not yet come under my observation as an adulterant in pepper, but its appearance in turpentine (which is identical in carbolic acid and when boiled in potash) is shown in Fig. 13, and is to be readily recognized. Capsicum is used in black pepper, not so much to adulterate it as to give the pungency lacking in the adulterants, and thus mask the adulterations by cheaper ingredients.

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The Internal Hairs of Plants.

BY J. KRUTTSCHNITT.

I have read with much interest the article on the "The Epidermal Organs of Plants," published in the June and July numbers of your JOURNAL, and devoting, as I do, also some attention to researches in the same field, I feel inclined to offer some remarks on the nature of the internal hairs of *Nuphar*. The writer of the article in question tries to establish a connection between the structures he finds in the leaves and petioles of *Nuphar* with the epidermis, and considers them the homologues of the external hairs of other plants. Their similarity with the hairs of the leaves of *Deutzia* is really striking.

The leaf of *Nuphar* may be separated into four or five layers: the upper cuticle containing many stomata, a parenchymatous layer, another parenchymatous layer containing the "stars," then the lower cuticle which is also composed of two layers.

The internal hairs of *Nuphar*, I believe to stand in no relation to the epidermis or to the stomata; but as an independent structure, the equivalent of the vascular system of other plants. In a preparation of a longitudinal section of a petiole of *Nuphar* the walls of the large canals are studded with "stars," while in the environing parenchymatous tissue the stars disappear to make room for elongated fibres, stretching up and down from a short pedicel, thus:

FIG. 30.

These fibres now and then overlap each other, and form a continuous line the whole length of the slide; or, in other words, a dotted vessel. In the same slide the vascular system, properly so called, is only represented by a single annular duct.

The cause of some of the structures in the leaf and petiole of *Nuphar*, assuming the stellate form, may perhaps be found in the circumstance, that in the loose tissue of the leaf, the vascular system is hindered in its linear development because deprived at intervals of a proper support; and in search of support it gropes its way from a common base in many directions, assuming thus the stellate form. In the petiole the vascular fibres find the necessary support which enables them to follow a straight line. The branches of the "stars" may also help to keep apart the air-chambers of the leaf, otherwise the loose cellular tissue would collapse.

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Remarks on the Preceding Article on "Internal Hairs."

BY CHAS. F. COX, F.R.M.S.

I thank you for your courtesy in allowing me to see Mr. Kruttschnitt's communication; but I do not feel that he and I are so seriously at variance in our views that I need to enter into extended discussion of them at present. One thing, however, seems to me beyond doubt, that in the leaf of *Nymphæa* or *Nuphar* the principal part of the "internal hairs" are planted in the uppermost parenchymal (or the only truly epidermal) layer, as may be seen in any good transverse section of the leaf, made at right angles to the mid-rib. In this respect, at least, they stand in a very evident relation to the epidermis. But there are also numerous hairs scattered through the lower parenchymal layers, projecting through the tissue into the intercellular spaces, and these, I imagine, are the continuation into the leaf of the system of "stars" which Mr. Kruttschnitt speaks of as studding the large canals in the petiole. The fact that these "stars" take, by preference, to the walls of the canals, is one indication of their similarity in habit to all external hairs. Perhaps at some future time I will undertake to present a theory of the variations in form and distribution of these internal hairs.

I have long been familiar with the elongated forms found in the petiole, but I cannot see their equivalence to a vascular system. The elongation I take to be a change of form occasioned by the rapid onward sweep of growth in the petiole, confined within narrow limits laterally; the "star" shape being the normal one of which this is a modification. The fact that the elongated hairs overlap one another occasionally, does not seem to me to indicate any real similarity to a vascular system, so long as there is no actual communication or connection between them; and the term, "a dotted vessel," strikes me as deceptive, since the dotting referred to is caused merely by the siliceous granules, which are common on all hairs. Finally, I cannot see that the branching of the "stars" is accounted for on the ground of necessity, since many other water-plants have a cellular structure quite as loose as that of *Nuphar* or *Nymphæa*, without possessing the "stars," to prevent its collapse; and the modification of a vascular system into disconnected, stellately-branching bodies for this purpose would seem to mean inconsistency of nature.

And now that I am writing, let me call attention to another branch of this general subject. In my paper on "the Epidermal Organs of Plants," I stated that no one, as far as I was then aware, had attempted to account for the existence of hairs on purely physiological grounds. Since the publication of my article I have seen, for the first time, Prof. J. C. Arthur's paper on "Various Forms of Trichomes of Echinocystis lobata," which was published in the

Botanical Gazette for March, 1881.

I copy below some passages from Prof. Arthur's paper which show that he and I were unconsciously working over some of the same ground at about the same time; and I am pleased to find that his researches led him, with regard to hairs being organs of the metastatic process, to substantially the same conclusion as my own. He says:

"All the forms mentioned in this article fall under one of two classes, capitate or filiform. Trichomes of the former class are inclined to be glandular while those of the latter are not. This accords well with their distribution over the plant surface. The filiform ones contain the more highly vitalized protoplasm, as manifested by its activity. They are situated on the parts of the plants which are destitute of stomata and growing rapidly, and consequently in need of some other means of directly absorbing water and oxygen from the atmosphere and soil. On the other hand the capitate forms are on surfaces well provided with breathing pores. The latter serve to absorb oxygen during the earlier stages of growth, while the stomata are inefficient. When the stomata perform their allotted function, and the intercellular spaces are free of sap and protoplasm, these capitate trichomes become glandular and are turned to other service, or disappear.

"Considered physiologically, trichomes are not indispensable to the plant, yet in a small way frequently render important assistance. The value of the root hairs is one of the best known facts in botany, being uniformly illustrated in general treatises, and insisted upon in horticultural essays on transplanting. Hairs on many plants serve for protection against detrimental changes of the weather, the attacks of animals, etc., but in *Echinocystis* the only trichomes that could be considered protective are those which roughen the leaves. Upon rapidly growing parts (especially true, *e. g.*, of young flower-buds) the abundance of delicate trichomes aids in supplying oxygen to the tissues. Stomata and air cavities perform this office in the older portions, but in parts newly formed the cavities are filled with protoplasm and cell sap, so as to prevent free circulation of air. Moreover, a very rapid supply of oxygen is required at this time to meet the needs of metastasis by which the increase of protoplasm and the formation and multiplication of cells is effected. The oxygenation of the plant in such growing parts is somewhat analogous to that of some polyps and worms having external filamentous gills, while later it assumes the more efficient internal respiration corresponding to that of insects.

"It has already been hinted that there is a similarity of function between the hairs of growing shoots and of young roots. Both subserve the interests of the plant by increasing the surface through which material for the plant's sustenance and growth may be absorbed. The character of such material is determined by the nature of the respective media in which the organs vegetate—of shoots it is gaseous, of roots aqueous."

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Wholesale Destruction of Acari by a Fungus.*

BY C. M. VORCE, F. R. M. S.

In March last, while passing a heap of stable manure, I kicked over a piece of board lying on the heap, and on glancing at the uncovered spot my attention was attracted by an appearance as if very fine meal had been sprinkled over the surface of the manure. Supposing this to be the spore-cysts of a fungus, I secured a quantity of the supposed fungus *in situ*. Under a pocket lens the surface of the material was seen to be thickly studded with minute, whitish, globular bodies, very much like, but somewhat larger than, the capsules of

*Read before the American Society of Microscopists at the Columbus meeting, August, 1881.

a mucor; no mycelium could be seen. On placing some of the material under the microscope with a 2-inch objective, the globular bodies were seen to be filled with spores, and closely resembled the spore-capsules of mucor, save in being larger and lighter colored, but still no mycelium was seen on the surface of the oat-hulls, fragments of stems, etc., to which the globular bodies adhered. But on picking off, with a mounted bristle, some of the globes and examining them separately on a slide, they were found to have legs, and to be, in fact, minute, hexapod acari (?), dead, and distended by the spores of some (Sphæriaceous?) fungus which had completely replaced the natural contents of the body. With much difficulty a view of the insect *in situ* was obtained, which showed it to be in a stiff, straddling and apparently unnatural position, nearly head downward, so that the head and legs were concealed from view by the swollen body above. On crushing the detached specimens in water, the contents of the body seemed to be matted together, but many free spores floated out, and were found to be globular and hyaline and of an average diameter of 0.001 of an inch.

This would seem to be a different fungus from the *Sporendonema musci*, which destroys the house-fly and other insects; but as all the specimens not immediately examined were soon afterwards accidently destroyed, this cannot positively be determined until others are found. Many insects are known to be attacked by various species of fungi, and beetles, flies, moths, locusts and larvæ of various kinds have been recorded as the victims; but I have never seen any instance recorded of any insect smaller than the mosquito being thus affected, and to find these minute acari thus destroyed by such a vegetable parasite is, to me at least, a new revelation.

That these acari were killed by the fungus, and not merely infested by it after death from other causes, would seem to be an unavoidable conclusion, from the fact that the insects were found in their natural and chosen abode, and under circumstances ordinarily favorable instead of adverse to their well-being, and also from the number so infested, their peculiar, unnatural position, so closely resembling that of the house-fly when thus infested, the absence of any apparent trace of the fungus outside the bodies, or on the material inhabited by the acari, and from the analogy of other similar cases of fungoid infection of insects.

The number of the insects seen on the spot on which the piece of board had lain was thousands at the least; doubtless they were but a small part of the whole number in the manure pile, as considerable rubbish was scattered upon it under which they might have hidden

How the insects became infested with the fungus is an interesting problem. In the case of larger insects the natural openings of the body are large enough to allow of the entrance of mycelial threads or the passage of spores, but in this case the spores are much larger than any of the openings of the body, and the only trace seen of any threads of mycelium or of any fungoid structures, besides the spores themselves, were a few excessively minute, glassy, acicular fragments on which the spores might have been borne.

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Terrestrial Diatoms.

[An article by Mr. Julien Deby, Vice-President of the Belgian Microscopical Society, printed in the *Bulletin* of that Society, in 1879, has just been recalled to our mind by a reprint in pamphlet form, and as the subject is quite interesting we have prepared the following condensed translation of his article.—Ed.]

In the month of May, 1848, Ehrenberg presented to the Berlin Academy of Sciences a note on the microscopic tree-fauna of Venezuela. The

list of species includes twenty-seven living forms, among which are found ten species of rhizopods and nineteen forms of diatoms.

In the month of October, 1848, Ehrenberg recounted his researches on the microscopic matters carried in the atmosphere. He found on the top of the veterinary school of Berlin *Eunotia amphyoxis* and *Pinnularia borealis*, two species which he had already indicated as characteristic of the dust of all parts of the world, and of all elevations.

By washing plums, purchased by him in Berlin, he found these same species in the water employed, and he obtained them again from mosses from Mozambique. Moss taken from a wall at Beirout, in Syria, furnished him with the same species, as did also some moss that he had taken from the famous cedars of Lebanon in 1820. He found them again on the summit of the towers of "la place des Gendarmes," Berlin.

In many instances these diatoms are specially mentioned by Ehrenberg as living, that is to say, retaining their endochrome, and in process of division. In his work published in 1871, Ehrenberg recalled the fact of a fall of meteoric dust at Calabre in 1813, which contained specimens dried during life at the time of multiplication. The dust which fell at Lyons in 1846, contained them with the endochrome still green. Since that time *Eunotia* (*Nitzschia*) and *Pinnularia borealis*, with colored contents, have been frequently found out of the water. In the dust collected in 1834 on the Russo-Chinese frontier, in 1844 at Quito, in 1848 in lower Silesia and in divers other localities this fact has been made known.

The celebrated micrographer inquired, in one of his later publications, but without being able to answer, how it happens that among the four hundred species of diatoms known by him in the vicinity of Berlin, it is possible that two species among the most common of those found in the atmospheric dust, and which are also those one finds most frequently in the dust that deposits in Berlin, should be of the greatest rarity in the living state at the level of the ground

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In conclusion, I believe that the diatoms mentioned above, and probably a considerable number of others, should be considered as habitually living on trees and in other places exposed to the atmospheric vicissitudes, particularly hygrometric. I therefore recommend to my colleagues the methodical washing of mosses, with a view of preparing a list of the bacillaria, which they contain, in a living state. The presence of these species in tree-mosses easily explains the fact of their presence in the atmospheric dust, when they are not found in the neighboring waters. This is the solution of the question which Ehrenberg proposed to himself without being able to resolve it.

It is quite possible that these diatoms are among those in which the phenomena of division and of conjugation and formation of spores are the most active, rapid and easy to follow, for these divers acts of life among them must depend upon showers or occasional rains, and cease at the return of dry weather. The study of these species will, without doubt, serve to corroborate the interesting observations of our colleague, Paul Pettit, on the revivification of diatoms.

It is especially from these physiological points of view that the study of terrestrial diatoms merits our consideration.

[We have omitted the lists of diatoms given in the original article, but the more common forms of terrestrial diatoms, besides those already mentioned, belong to the following genera: *Eunotia*, *Navicula*, *Orthosira*, *Nitzschia*, *Amphora*, *Pinnularia*, *Stauroneis* and a few others.—Ed.]

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An Introduction to the Study of Lichens.*

BY THE REV. W. JOHNSON.

The group of plants, which is to occupy our consideration in this paper, has until recently been regarded as the "approbria" of our Cryptogamic Flora; and these humble members of the vegetable kingdom may still be so regarded by many people. But, when we become acquainted with the Lichens, when we take time to behold their hidden beauty, to understand their structure, their habits, uses and modes of growth; when we feel the thrill of enthusiasm which they can impart, and when the frail things, dried in the herbarium, gather around themselves some of the sweetest associations of our life—associations redolent of the woods, the heaths, the mountains and the shore; then, disregard of them, much more despising them, becomes a matter of surprise. Disregard, or despicable feelings in relation to Lichens, may arise from ignorance; but they cannot arise from any lack in the plants themselves of those qualities which create and sustain interest; nor, from any surrounding difficulties which are insuperable to a pleasant, profitable and useful study of them. There are difficulties in the study of Lichens, and perhaps, some which are peculiar; but, as in all things else, an unenlightened imagination magnifies them. The chief obstacles here are two. These are the terminology and the determination, or the distinction of the species and varieties. The first is the common tax of knowledge in all her departments. You must master the phraseology before you can know the subject. The second is a difficulty which now, when it is the greatest on account of the many forms discovered, the differences of which are small; yet, it is the more easily overcome, because the very growth of our Lichen-flora has resulted in a more natural and comprehensive classification, as well as in a better and more certain method of study. As in other departments of nature, the microscope has here come to our aid; and now, by comparing the internal structure, the shape, size and color of the spores, with the outward features of the plant, the determination of species is more easily and correctly attained, than when such determination was made simply by observing the external characteristics alone. Beyond these two checks, the path in lichenology is comparatively smooth, and abundantly healthful and enjoyable.

Lichens are a class of plants in the secondary division of the vegetable kingdom. They belong to the Cryptogamia or flowerless plants. Their position in that division is between the fungi on the one hand, and the algæ on the other. The difference between the Lichens and those two adjoining classes is not so great that their boundaries are unquestioned. Nor yet, are their affinities so close that the Lichens are not clearly distinguished between the two. Nature has no sharp and fast lines in her divisions. Her boundaries generally overlap, and it is so here. The Lichens run into the fungi in the corticulose Verrucareæ, and into the algæ in the gelatinous Collemacei. In a new text book on botany,* recently translated into our language, Lichens are no longer regarded as having a distinctive existence. Their position as a separate class of plants is spoken of as a thing of the past. They are here placed in the order of Ascomycetes amongst the fungi. This new departure in relation to Lichens, which, to say the least of it, is somewhat presumptuous as well as premature, is founded upon a theory propounded by Schwendener some

* From the *Northern Microscopist*. The illustrations to accompany this article will be printed with the continuation next month.

* Text Book of Botany. Prank & Vines, 1880.

few years ago, and now well known amongst lichenologists as the "Schwendenerian theory." Briefly expressed, this theory is that—Lichens are not autonomous plants; not individuals, in the ordinary sense of the word, but a compound of filamen ous hyphæ of the fungi and the green matter of the algæ. The medulla of the Lichen is the supposed fungus; and the colored gonidia which are found in Lichens, the supposed algæ. The fungus is said to be parasitic upon the green cells of the algæ, holding them as prisoners and slaves, and by their activity nourishing its own growth. We cannot discuss this theory here; nor would it be prudent to enter into it in any large way. But, we may remark upon it, that, supposing Schwendener's hypothesis were true, still, the Lichen would be a distinct plant, and would have a claim to be so recognized. Inasmuch, as the supposed fungi and algæ combined produce a plant differing from either of themselves, and which could not exist if they were separate; also, if either the green cells, or the hypha, produce the one or the other, then they are no longer either algæ or fungi; for a true alga does not grow fungal hyphæ, nor does a true fungus produce green algal cells. But the Lichen has its own independent characteristics, independent either of fungi or algæ. It has its own distinct and definite forms, its own habits of life, its own organs of self-propagation; and if fungi or algæ were by some means obliterated from the earth, so far as their presence is concerned, Lichens would continue to flourish all the same. But further, most or all our leading lichenologists are against this dual-hypothesis of Schwendener. This does not prove the theory untrue, we know, but it is a fact which carries great weight, when we reflect that they who have made Lichens a special and a life-study, must be allowed to be as well or better acquainted with them than men whose investigations have for their object merely the founding or support of a theory. Dr. Nylander, than whom does not live a greater authority on Lichens, by his own investigations and from his own knowledge, has repeatedly shown the absurdity of Schwendener's theory; and he speaks of it as "that hypothesis which none indeed but tyros can patronize." "An hypothesis informal and absurd, supported by no serious observations." As to how Lichens shall be regarded anent this hypothesis, Mr. Bentham considers that "whatever be the result, the group of Lichens is so distinct in its negative characters, and at the same time so extensive and varid a one, that it seems more methodical to treat it, as heretofore, as a distinct class, than to absorb it in that of fungi, notwithstanding the close affinity shown by its reproductive organs." In as brief a manner as is consistent with clearness, we shall now endeavor to give some description of the Lichen organism, with some reference to its habits and uses; and then drop a few hints relative to the study of this group of plants. The Lichen, as a plant, has no axis, either ascending or descending; no branches or leaves in the same sense as phenogamous plants. Its nearest approach to a leaf can only be called a lobed or laciniated frond. Its vegetative or expansive portion is denominated a thallus. (Gr. *thăllŏs*, a young shoot or frond.) The thallus may be said to comprehend the whole plant, inasmuch as it contains within its tissues, or bears upon its surface the reproductive organs, both male and female, with their fruit. The form which the thallus assumes in growth is very variable. So is its consistence, size and color. It will sometimes expand to one or two feet in diameter; while, in other forms, it will present a small gray or colored spot; and often nothing but the fruit will be seen, the thallus being evanescent. The typical forms of the thallus are

vertical and horizontal. The vertical, or free thallus, is divided into fruticulose and filamentous. The former is a shrub-like aggregation of segments or portions, springing from a centre; and they are either narrow or broad, round or compressed, simple or branched. Cladonia and Ramalina are fruticulose forms. The filamentous species are more elongated than the fruticulose. They are round and thread-like, more or less clothed with divergent fibrils. *Usnea barbata* (Fig. 31) shows this form of Lichen.

The forms of Lichens just named are those which give the aged and venerable appearance to many of our forest trees, and present them to our sight so shaggy and hoary, as almost to move our pity, while they command our reverence. Wordsworth's "Thorn" must have been covered with these Lichens. He tells us :—

"There is a Thorn, it looks so old,
In truth you'd find it hard to say
How it could ever have been young,
It looks so old and gray.

* * * * * * * * * * * * * *

"Like rock of stone, it is o'ergrown
With lichens to the very top,
And hung with heavy tufts of moss,
A melancholy crop."

The horizontal thallus embraces the crustaceous and the foliaceous species. The crustaceous (Fig. 32) predominates in number over all forms. It closely adheres to the surface on which it grows. In growing, it sometimes assumes a determinate shape, and has a distinct margin when it is called determinate or uniform. When it spreads itself irregularly it is said to be effuse. The thickness of the thallus, and the condition of its surface show many modifications, which are all considered in the distinguishing of species. The foliaceous or frondose thallus is the most leaf-like of all Lichen growths, and is considered by some as the highest Lichen development. It is a flat, light gray or green expansion. Its margin varies in different species. Sometimes they are irregularly torn into lobes or lacerated, sometimes the lobes are crenate or sinuate or upturned. The margins or lobes are at other times cut into laciniæ, these are narrow and linear, or sinuate segments. The foliaceous thallus is most frequently green above, and light or dark colored beneath. On the under side it is sometimes villose, or else has a number of short fibres or bundles of fibres called rhizinæ. These have the appearance of small rootlets, but do not act as such; they simply fix the plant to the matrix or place of growth. Within these general distinctions the Lichens show many features and variations, some of which are characteristic and permanent, others dependent and changing. But these can only be understood by the initiated, yet they are gradually and soon learned by the careful and diligent student.

The structure of the Lichen thallus is much alike in all forms; but there is a difference between the gelatinous family and the rest. In the large family of Lichenacei or non-gelatinous plants the thallus is almost invariably stratified, and consists of three distinct layers of cellular tissue. But in the family of Collemacei, while there are found the three forms of tissue just referred to, yet they are not stratified. The hyphoid and green cells being mingled together throughout the thallus. In one branch of this family—the Collemas—there is no distinct cortical layer. Another point of this difference between these two families is observed in the arrangement of the gonidial cells. In the non-gelatinous plants the green cells are generally free, but in many of the Collemas they are joined together in a moniliform manner, or in the fashion of beads on a string. In some members of the family they are diffused through the thallus, while in a few others they are grouped into small series of cells.

(*To be continued.*)

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EDITORIAL.

MICROSCOPICAL SECTION OF THE A. A. A. S.—We are informed, by the Rev. A. B. Hervey, that at the Cincinnati meeting of the A. A. A. S., the microscopical sub-section was changed into a full "Section of Histology and Microscopy." Hereafter, the Chairman will be a Vice-President of the Association, and the section will be represented in the standing committee by the Chairman, Secretary and one Fellow.

Prof. A. H. Tuttle, of Columbus, was elected Chairman for the next meeting, which will be held at Montreal, and Mr. Robert Brown, Jr., was made Secretary. Next month, we shall print the article read at the meeting by the Hon. J. D. Cox, on the conjugation of *Actinophrys sol*, which is very interesting.

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EXCHANGES.—It is not usual that we know just what kind of material is offered for exchange on our last page, and we cannot, therefore, be held in any wise responsible if those who make exchanges do not always receive objects equal to those they send out. Some disappointments will necessarily arise from this source, but we have heard only a very few complaints thus far. Miss M. A. Booth offers some most excellent material in the form of diatoms *in situ*, specimens of which we have seen, and our readers would do well to obtain some of her collections for mounting.

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CROTON WATER.—In addition to the list of algæ found in Croton water, printed last month, a number of other species have since been determined, and still others are found which we have as yet been unable to classify. The life-history of most of the so-called unicellular algæ is not known, but it is supposed that these simple forms of vegetal life are, in many cases, the spores, or developmental stages, of higher algæ. Nevertheless, specific names have been given to them, and they are not without value in the present state of our knowledge. But many of the forms are so indefinite that it is almost impossible to identify them with any one described species. Hence, there is a considerable number of minute forms to be found in Croton water, to which we have not ventured to give names. As an example of what we have stated, we may refer to the plant named in our list *Palmodactylon varium*. There was certainly found a plant which, in all respects, agreed with Rabenhorst's description and figure of that species. However, later examinations of the sediment have almost convinced us that the plant we have thus named, and which Mr. Wolle regarded as correctly named, is merely a stage in the life of *Cœlosphærium dubium*, the gelatinous spherical families of which show a tendency to break up in this way. However, that they actually do break up in this way is not yet positively demonstrated, but we have pretty strong evidence, that they do. *C. dubium* is now exceedingly abundant in the Croton water, but the Anabænas have almost disappeared. In addition to the forms named in our preceding list we have found the following species :—

Anabæna bullosa.
Anabæna———.
Scendesmus acutus.
Staurastrum megacanthum.
Spirogyra Weberi (?).

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OBJECTIVES.—Dr. Carpenter, in the last edition of his book, has written some plain words about the relative qualities of objectives. Without intending to reopen the discussion of the intrisic merits of high and low-angled objectives, about which there is no longer any occasion for controversy, since the matter is capable of accurate mathematical demonstration, we still believe that a little whole-

some advice, such as Dr. Carpenter has given, will prove of interest.

For the general purposes of the microscopist, Dr. Carpenter strongly favors moderate angular apertures. He says, referring to the wide angles : "But here comes in another source of impairment [of definition],—the difference in the perspective views of every object not a mere mathematical point or line, which are received through the different parts of the area of the objective," and as this difference "increases with the angle of aperture of the objective, its defining power must be proportionally impaired." If this is intended to imply that increase of angular aperture impairs definition, then we cannot agree with the writer. But we are inclined to put a different interpretation upon the results to which he alludes in support of the above statements, and to say that any apparent defect in the definition of a good wide angled glass, in a particular case, is due, not to imperfections of the objective, but to the unsuitable nature of the object, for examination with that glass. The experiments alluded to by Dr. Carpenter do, indeed, tend to show that two or more objectives of different apertures, may be used with advantage in the study of unknown objects ; for the appearances of the image may be materially altered by a change of the angular aperture. But apart from the question of definition, it must be conceded that for general work, the moderate apertures possess qualities which make them to be preferred above all others. Dr. Carpenter states that "it is also the experience of Messrs. Dallinger and Drysdale, that for the definition of the immeasurably minute reproductive granules of the Monadine forms, * * * * or of the flagella of *Bacterium termo*, which may be characterized as the highest feats of biological microscopy yet performed, *moderate* angles of aperture are unquestionably to be preferred." We were somewhat surprised to read this passage, but we have no reason to question its truthfulness, although at first, we would have supposed that for such work, the widest angles would be the best. But the resolution of close lines, and the definition of isolated particles, or flagella, do not require the same optical qualities. This fact has been too often overlooked in controversy. In the face of these statements, and of the testimony of Prof. E. Abbe, who himself recommends the use of moderate apertures, and, we may add, of the almost universal verdict of experienced microscopical investigators in all countries, we fail to see why a few persons should persist in declarations contrary to these. The trouble has been that objectives have been studied and judgement passed upon them from a point of view entirely too narrow. It is one thing to try a lens upon test-diatoms, and carefully prepared histological specimens, and quite another matter to use it in the daily work of examination, when it would be a useless and unnecessary waste of time to carefully mount every specimen.

We have, therefore, the concurrent testimony of those men, who are unquestionably able to speak with authority on the subject, that "great revolving power is only exceptionally needed in the most difficult biological investigations ; what is especially required for the study of living and moving organisms, being such a crisp and clear definition, good working-distance and considerable local depth, as high-power objectives of the widest aperture cannot afford."

The fallacy of judging the quality of an objective by subjecting it to any one test, has been recognized by the practical experience of a gentleman in this city, who has given considerable attention to the comparison of objectives. As the results of his examination of three lenses by different makers using *A. pellucida* as a test object, he considered that there was very little choice between them, although there was considerable diffe-

rence in their cost. But he was careful to add that, in his opinion, the general excellence of the objectives was not indicated by such an examination.

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About Microscope-Stands.—Although it must be generally admitted that the microscopes now made are, mechanically, excellent, and well adapted to the demands of the trade, and while it is not our intention to enter upon a lengthy *critique* of the various designs, a few words of suggestion at this time may not come amiss to both manufacturers and purchasers. There are, in fact, but very few stands in the market which, in design, are equal to what we are yet to see offered for the same or even lower prices. No doubt the reason for this is that the makers are not usually themselves engaged in microscopical work, and, therefore, they can only act upon the often conflicting opinions of those who are. We propose to write a few words about stands now, and next month to add a few suggestions about accessories.

There can be no doubt that the time of large and costly microscopes is passed. Indeed, there will always be some persons who will want them, but the experienced worker, whether he be an amateur or a professional man, will surely discard them. Solidity and steadiness can be secured without excessive weight, and the smaller and the more compact a stand can be made, without sacrificing convenience of manipulation and effecttiveness, the better it is. Now, a stand that is sixteen or eighteen inches in height is very inconvenient to work with. It is very showy, and doubtless affords the owner great satisfaction to exibit it; but we will venture the assertion that if there were no such large stands in the country, there would be more original microscopical work done. It is an undeniable fact, which will be admitted by every investigator who has used both large and small stands, that the latter are by far the more convenient. Therefore, we say that the best and most salable stands of the future will be low stands not much higher than the common German model. There seems to be some advantage in having the body-tube large, and there must be sufficient space beneath the stage for the ready use of substage accessories. We regard an independent substage as almost indispensable, but it is by no means necessary that it should be a swinging substage. In fact, the value of the much-lauded swinging substage is, in our opinion, very questionable, and certainly when the mirror and substage are both mounted upon the same swinging bar, as in most of the instruments now made, we would prefer the stationary substage and the independent mirror. These opinions have been held by us ever since Mr. Bulloch showed us (about the year 1870) one of his first swinging substages, and later experience has only served to confirm them. The same opinion has lately been expressed before the Royal Microscopical Society of London, and while there are some differences of opinion, we think it will be difficult to prove that the swinging substage possesses any considerable value. We willingly admit that if it can be moved independently of the mirror it may prove to be convenient and useful, but when it is fixed to the mirror-bar its usefulness is very problematical. It need scarcely be said that we regret that our opinions in this matter should be so greatly at variance with those which have guided our manufacturers of microscopes in designing their best stands; but they are founded upon practical experience, and not wholly upon *á priori* grounds. In thus freely giving expression to them, we are actuated by no spirit of criticism, nor do we imply any invidious comparisons, but we consider that the interests of both makers and purchasers would be advanced by an impartial examination of this subject, and by a willingness, on the part of

the former, to act upon the conclusions thus attained.

Another suggestion we have in mind relates to the polariscope. This useful accessory is not readily applied to any of the stands made in this country, except those specially designed for mineralogical work. Some ingenious arrangement should be devised whereby the polarizer can be swung into place and removed as readily as objectives can be changed by a double nose-piece, and the analyzer should be arranged for equal convenience of application.

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ZEISS'S CAMERA LUCIDA.—Through the courtesy of Mr. Fr. Emmerich, of this city, who has lately received a number of articles from Mr. Zeiss, among which, in a ⅛-inch homogeneous immersion objective, we have been enabled to make use of the two-prism camera lucida by Zeiss; as this accessory is almost unknown in this country, an account of its performance may be of interest.

The instrument consists of two prisms so arranged that when placed over the eye-piece, with the microscope vertical, an image of a portion of the surface of the work-table is projected into the field of view, so as to be distinctly seen together with the object on the stage. The drawing paper may be placed either on one side of the microscope or behind it, as may be most convenient, but if on the side, the paper should be inclined about 15° or 20°; if behind the microscope, the stand itself may be inclined instead; and this we find to be the more convenient and simpler plan. We have been very much pleased at the ease with which the pencil-point can be seen with this camera lucida. In this respect it is superior to any other that we have tried, although our experience in this respect has been rather limited. Moreover, it is much less troublesome to work with than the Wollaston prism, which is the one in most common use in this country. It meets one great desideratum in a camera lucida, viz., that it can be instantly applied while the microscope is vertical or at a slight inclination, without any change of conditions, such as are necessary with the Wollaston form, which not only cause trouble, but also much loss of time and often the loss of the object. Our experience, after finding a beautiful desmid, for example, which we desired to portray on paper with the Wollaston prism, has at times been very trying. First, the slide must be secured in place, then the microscope must be elevated to a suitable height on a pile of books or boxes, and a large space on the table cleared. Then, after arranging the tube horizontally, the object must be illuminated and focussed—probably it must be searched for again—and then we are about ready to draw. How much simpler it is to merely adjust the Zeiss prism over the eye-piece, place the paper on the table, adjust the light and proceed with the drawing

We have given considerable space to this subject, because we believe that if a good camera lucida, which could be thus readily used, were in the hands of our microscopists, many more drawings would be made, and habits of close observation would be thereby cultivated. We can heartily, and without hesitation, recommend Mr. Zeiss's form, and hereafter we propose to use it ourselves.

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THE HOLMAN COMPRESSORIUM.—We have received from the manufacturers, Messrs. J. W. Sidle & Co., one of their new Holman compressoriums, and after a fair trial we can confidently recommend it as a very useful accessory for the microscopist, especially in the study of minute animals in water. It seems to be disproportionately large, but probably the makers have good reasons for making it so. The cover is of mica and is, therefore, not easily broken.

The under glass is moved up and down by means of a convenient screw, while the cover remains stationary, and the motion is very smooth. A good compressorium is of great value to the general microscopist. Americans have not yet come to appreciate it; by its use, many points of structure can be easily demonstrated without resorting to delicate and tedious dissections. The price of this instrument is only $4.00.

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THE BORING SPONGE.—The July number of the *Journal of the Quekett Club* contains three articles upon sponges, which possess considerable interest. The first is by B. W. Priest, "On the Natural History and Histology of Sponges," but the second article "On *Cliona celata*—Does the Sponge make the Burrow?" by J. G. Waller, and the last one, by Mr. Priest, in which the same subject is considered, are deserving of special notice. In the opinion of Mr. Waller, the sponge is not capable of boring or excavating in limestone-rock or shells, either by a mechanical process of abrasion or by chemical action, and he believes that the burrows inhabited by the sponge are all produced by the boring of some annelid, regarding the sponge as parasitic. By microscopical examination he traces a similarity between the excavations inhabited by the sponge, and others which are unquestionably produced by annelids boring with a hard tool working in in the segment of a circle, as the larva of *Scolytus*, for example. The parasitic nature of the sponge is indicated by its habitat in deserted polypedoms of Polyzoa, the tubes of Scopulæ, etc. Mr. Priest holds to the opposite opinion, although admitting that it is still a problem how the sponge can penetrate solid limestone-rock. He was at one time inclined to the belief that the boring was done by other organisms, but after a more careful study of the subject, he found cavities "which ramified right and left into such fine processes, and those cavities being filled with the sponge," he finally concluded that no annelid could produce such work. The whole question is left in a state of uncertainty; and we are inclined to ask, if the boring sponge is misnamed because it cannot perforate hard substances, what is the nature of the magnanimous creature that prepares its dwelling places?

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FILARIA IN THE BLOOD.—An interesting letter from P. Manson, M. D., who has been studying the filariæ in the blood of two Chinese lads, to Dr. T. Spencer Cobbold, is printed in the *Journal of the Quekett Club* for July. The filariæ are long, hair-like worms belonging to the Entozoa. They are found in the blood of persons who may apparently enjoy good health at the time. They seem to occur quite frequently in China. A most mysterious phenomenon connected with these organisms is their periodicity. Between four and six o'clock in the afternoon the filariæ begin to appear in the blood, their number increases until midnight and then diminishes until nine or ten o'clock in the morning, when they have entirely disappeared. This daily periodical recurrence of the worms seems to be quite independent of the habits of the patient, and has not yet been explained.

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THE MICROGRAPHIC DICTIONARY.—The first two parts of the fourth edition of this valuable publication, which, as announced in these columns last month, is to be published in monthly parts, have been issued.

The work begins with the "Introduction," which is somewhat longer than and different from that of previous editions. Owing to the peculiar nature of the book we cannot attempt to notice the contents in a specific manner; but looking over the pages we find evidences of the

careful work of painstaking editors. No very extensive alterations in the text, however, have been made thus far; but as yet we have only seen thirty-two pages of the dictionary proper, and we have reason to expect great changes in some places. Four plates, engraved on metal, accompany each part, two of them, one representing desmids and the other sections of rocks, being printed in colors; the others represent diatoms, vegetable tissues, foraminifera, entozoa and adulterations,—the latter is a new plate, as is also one plate of foraminifera.

Without dwelling longer upon the contents of the parts before us, we feel disposed to say a few words about the general usefulness of the work. Persons who use the microscope for pleasure or recreation, constantly find new objects which they are unable to classify. The numerous plates in this dictionary afford great assistance in many cases of that kind, and to the amateur it should, and we hope and believe that the fourth edition will, meet this growing want among general students more perfectly than its predecessor.

Specialists in their chosen branches will find the different departments of study with which they are unfamiliar treated by competent authors. Those who cannot afford to buy a number of large and costly volumes treating of the various subjects in which they are interested would find this dictionary an excellent substitute. The parts are published at *2s. 6d.* each, and the postage will be about *2d.*, making *2s. 8d.* to subscribers in this country, or 68 cents.

It is thought there will be twenty-one parts in all, making the cost of the complete work $14.28. The old edition, bound, now sells for $22.50. Many persons object to subscribing for books published in parts; but when a work of this kind is undertaken by Mr. Van Voorst, to whom the scientific world is indebted for so many valuable and expensive works, no person need hesitate from any want of confidence in the representations of the publisher.

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DOUBLE-STAINED BLOOD-CORPUSCLES.—A few days ago, we had an opportunity to examine some of Mr. A. Y. Moore's preparations of Blood-corpuscles, at the store of Mr. Geo. S. Woolman, and it affords us pleasure to call the attention of our readers to these most excellent preparations. They are all very neatly mounted and the corpuscles are very evenly spread over the slides. Among the double-stained preparations, we found blood-cells from the snapping turtle, the common turtle, the frog and the perch, in all of which the nuclei were colored blue and the rest of the corpuscles red, the distinction being sharply defined. These slides are a novelty well worth possessing.

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THE MICROSCOPE AND ITS REVELATIONS.—The sixth edition of this valuable work, by William B. Carpenter, has been before the American public for about a month, and we understand from the publisher (Presley Blakiston, Philadelphia) that many copies have been already sold. The main features of the book are so well known to microscopists generally that we will only notice a few of the additions to, and improvements upon, the last edition.

In passing we must call attention to the fact that Prof. Riddell was the inventor of the first successful binocular microscope, and not M. Nachet, as stated on p. 33.*

In the description of microscope stands, American manufacturers have been almost entirely ignored. The new microscope designed by Mr. George Wale, is the only American stand illustrated; and, although Mr. Zentmayer has received some credit for his improvements, these are described in connection with the stands by Ross, but further than this Ame-

* This JOURNAL, Vol. I, p. 221.

rican makers have been overlooked—yet the author should know that some of the best designed stands now in the market are manufactured here.

With regard to objectives, Dr. Carpenter still ably defends the position which he has always held, that moderate angular apertures are the best for general use.

In the chapter on the preparation and mounting of objects, many changes and additions have been made, whereby it is greatly improved.

Considerable new matter has been added to the part which treats of the lower forms of plant-life. The development-history of *Bacillus anthracis* is quite fully recounted, with the aid of illustrations, and the Myxomycetes are treated at considerable length.

The chapter on the Protozoa has been greatly extended and a number of illustrations have been added; the Rhizopoda are more fully described than in the previous edition, but the diagrammatic representation of *Amœba proteus*, on page 486, shows a "villous tuft" which is not characteristic of that species as defined by Leidy.

A good summary of the researches of Messrs. Dallinger and Drysdale upon flagellate infusoria is given, and in the same chapter much new matter has been added, with new cuts, relative to the microscopic forms of animal-life. The department of microscopical lithology and mineralogy is very satisfactory indeed, and it is particularly valuable on account of the references to other sources of information, which are very well chosen. On the whole, the book is greatly improved in many ways, and we do not hesitate to declare our belief that it is the best book in the English language for general microscopists.

CORRESPONDENCE.

To the Editor:—How close lines have been resolved, and how close they can be resolved, are questions of interest not only to the microscopist, but also to the physicist, the physiologist and the instrument maker.

Nobert's old theory, that it was impossible to see lines closer than 85,000 (?) to the inch has been disproved for fourteen years. There have been published in journals, within the last two years, claims that lines 120,000 to the inch have been resolved. Many who have experimented in this work doubt if it has ever been done.

The deciding between the true lines, and spectral or diffraction lines (Abbe's theory requires that the diffraction lines only should be visible) can be done only by one who has great experience in this work; and one who claims to have seen such close lines should be prepared with satisfactory evidence of his experience, and of the fact.

It is known that there are in this country two plates ruled by Nobert twice as close—so he said—as his noted nineteenth-band plate. The last information about them was, that with the largest battery of the best objectives in existence, with the most extensive equipment of apparatus for all illuminations, a most experienced observer "could not get one peg beyond the 120,000 to the inch."

It is to be hoped that your correspondents will accept your invitation and communicate what they *know*, and the evidence of what has been done in this line.

While one may hope that lenses may yet be made to resolve 120,000 lines to the inch, we must yet say that satisfactory evidence that it has been done is still lacking.

Carl Reddots.

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To the Editor:—With thanks to yourself and Mr. Hanaman for the valuable practical "Notes on Microscopical Technology" recently given to your readers, I wish to suggest an improvement upon his last suggestion. He says truly that, "From the fact that the glass slides are not perfect rectangles, it is necessary to place the same corners in the same clutches of the self-centering turn-table." And he adds that, "the simplest way to do this is to mark one of the clutches with a cross, and similarly to mark with a file or writing diamond one corner of each slide while cleaning it." I think it will be found quite as simple, and for obvious reasons much better, to pursue the following plan which I devised a couple of years ago and have constantly applied ever since. Mark one of the clutches as indi-

cated, and then, instead of the file or diamond, have within easy reach on the work-table an open box of pieces of gummed paper cut into squares of about ¾ inch.

Whenever a slide is placed on the turn-table, stick one of these pieces upon the end of the slide in the clutch which has the mark. It will thenceforward serve the purpose of the proposed file mark, and, what is of very great practical value, that of a temporary label easily removed to give place to the permanent label at the finish of the slide. In the use of this simple device, entering the record of the object on this temporary label as soon as mounted, there can be no danger of losing memoranda, no matter how many slides he may have "under way."

J. T. BROWNELL.

[A plan for marking slides temporarily while mounting, which we have used with perfect satisfaction for a long time, is to use an ordinary ink mark. It is quite practicable to write upon a slide with a pen, and the ink will remain until it is removed with a damp cloth. – ED.]

NOTES.

—The value of the Microscope as an aid to Mineralogy and Metallurgy is well shown by an article recently published in the *Bulletin* of the Museum of Comparative Zoology, by M. E. Wadsworth, on the Iron Ore of Iron-Mine Hill, Cumberland, R. I. The Microscopical structure, taken in connection with the minerals associated with the ore, which is a titaniferous magnetite indicates that the rock is an eruptive formation, and the iron-worker can now decide intelligently as to the best method of working the ore.

—Mr. Henry M. Douglass has begun the publication of a translation of the *Botanishche Zeitung*, edited by A. de Bary, as a monthly at $2.50 per year, under the name of *Botanical News*. We would be pleased to see this enterprise well supported by botanists throughout the country, but we feel disposed to ask why it is that the botanists, of whom there are so many in the United States, do not give more liberal support to the two botanical journals, the *Bulletin af the Torrey Botanical Club*, and the *Botanical Gazette*, which are already well-founded? We are assured that the subscription-lists of these papers are ridiculously small, considering the number of botanists who should take them, and the natural inference is that our botanists are either all extremely impecunious, or else that they do not take much interest in the literature of botany. The *Botanical News* is published at Richland, N. Y.

—Prof. R. P. Whitfield has published a short article in *The American Journal of Science*, in which he expresses the opinion that the fossil remains found in the Chumung rocks of this State, and elsewhere, which are known as *Dictyophyton*, heretofore regarded as algæ, are probably the remains of sponges allied to *Euplectella*, but rather less complex in structure than the latter. Dr. J. W. Dawson, in a note appended to the article, fully sustains this view, from the results of his examination of a specimen furnished by Prof. Whitfield.

—Mr. J. Lee Smith, of this city, has prepared some very attractive slides in this manner: The glass slips are first coated with photographer's "Granite varnish" by flowing, just as a plate is coated with collodion in photography. This coating of varnish gives the slide the appearance of finely ground glass. It is then placed on the turn-table and, by means of a knife-blade, the varnish is entirely removed from a circular spot in the centre, just large enough for the cell in which the mount is to be preserved. The preparations we saw were mounted in glycerin, and the clear and transparent cells were made of Brown's rubber cement, which Mr. Smith regards as a most excellent cement, especially for glycerin mounts. Imagine a slip of ground glass with a transparent spot in the centre upon which objects can be mounted, and one can thus form an idea of the appearance of these slides.

—A writer in the *Northern Microscopist* for August has given a short account of various turn-tables, and describes one which is capable of making either circular or oval cells, and which can also be used for cutting thin glass covers. Among the turn-tables mentioned one of the best in the market, the "Congress" of Mr. Bulloch, has been entirely overlooked, and several of the later American forms have been entirely ignored.

—M. Nachet seems to have devised a practicable method of attaching and removing objectives without the use of screws. The nose-piece of the microscope is so arranged that by simply pulling down upon it the objective can be slipped in laterally, and it is then held in place by a spring in the nose-piece.

NOTICES OF BOOKS.

The Student's Manual of Histology, for the use of Students, Practitioners and Microscopists. By Chas. H. Stowell, M.D., Assistant Professor of Physiology and Histology, and the Instructor in the Physiological Laboratory of the University of Michigan. Illustrated by one hundred and ninety-two engravings. (Pp. 290). Detroit: Geo. S. Davis. 1881.

The matter of this book is well arranged, and the information concisely given. It is a pleasure to find a work on histology so completely devoid of unnecessary details concerning the technical processes of preparing and examining tissues. It is just possible that some additional instruction in this connection, would enhance the value of the book to beginners, but if the author has committed an error in this respect, he has surely erred in the right direction. In the Preface, he states that: "Those methods are given which are most familiar and which have proved the most satisfactory in our hands." If all writers would follow such a rule, not only would the student find less to confuse him in a multiplicity of processes from which to choose, but he would also be relieved of many disappointments from experiments with inferior or half-tried methods.

The different animal tissues are very clearly described, with the aid of numerous illustrations, and when authorities differ in their views, both sides of the subject are fairly presented. Prof. Stowell inclines to the opinion that the red blood-corpuscle possesses a nucleus, but he adds that "such is not the generally accepted view." In one place, he remarks that the nucleus of a cell is derived from the nucleolus, but this assertion may require confirmation before it can be accepted in all confidence.

We are also inclined to believed that the structure of the cilia of ciliated epithelium is far less simple than would be inferred from the statement that: "These cilia are but prolongations of the fine protoplasmic filaments,—the intra-cellular fibrils—through the base of the cell." It will be seen from this quotation, that the author adopts the opinions of Klein, Heitzmann and others, concerning an intra nuclear and intra-cellular, net-work.

The book is well printed, neatly bound, and has a good index.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Well-mounted Histological and Pathological slides in exchange for other first-class slides.
W. H. Bates, M.D., 184 Remsen St. Brooklyn, N. Y,

Wanted—first-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.
M. A. BOOTH, Longmeadow, Mass.

Wanted—Human Muscle with Trichina, in exchange for well-mounted slides of vegetable drugs.
OTTO A. WALL, M. D.,
1027 St. Ange Ave., St. Louis, Mo.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond,Va.

Section of Brain, stained, showing Tubercular Meningites; also Carcinoma Cerebri. Please send list.
L. BREWER HALL, M. D., 27 South 16th Street.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoœ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides*.
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

Well-mounted diatoms, in exchange for *any well-mounted slides* or material, etc.
W. H. CURTIS, Haverhill, Mass.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Slides of hair of *Tarantula*, very curious; also crystalline deposits from urine, to exchange for well-mounted slides. S. E. STILES, M. D.,
109 Cumberland St., Brooklyn, N. Y.

Fine injected specimens of kidney, tongue and liver, also very fine slides of human tooth, prepared according to the method of Dr. Bödecker, showing the protoplasmic net-work between the dentinal canaliculi, in exchange for first-class histological and pathological slides, or other good specimens.
J. L. WILLIAMS, North Vassalboro, Me.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

THE AMERICAN
MONTHLY
MICROSCOPICAL JOURNAL

VOL. II. NEW YORK, OCTOBER, 1881. No. 10.

An Introduction to the Study of Lichens.

BY REV. W. JOHNSON.

(*Continued from page 171.*)

The stratified cellular layers of the Lichen proper are called :—1. The cortical layer (1 and 4, Fig. 33). This is the outer covering of the thallus ; and is a somewhat tough, transparent, cellular membrane. In *Peltigera horizontalis*, we found it to be three or four cells deep ; these cells in the horizontal thallus, are generally angular from lateral pressure ; but in fruticulose forms, as in Ramalina, they are tubular and elongate. 2. The gonidial layer (2, Fig. 33). This lies immediately beneath the cortical stratum, and is composed of globular, free, bright green, yellowish, or bluish-green cells. The gonidia, in some species, instead of being simple cells filled with green

FIG. 31.

granular matter, are found to consist of clusters of two, three, or more roundish granules, with no distinct cell-membrane. These are termed, granular gonidia. 3. The medullary layer (3, Fig. 33). This is a mass of cylindrical, interlacing, articulate, colorless cells ; which are so woven together, as often to make a milk-white or flesh-colored spongy mass. They enclose the gonidia on the under side of the thallus, and constitute the base of the plant. These three cellular layers are quite distinct from each other ; so clearly, that in some of the foliaceous Lichens, they may be recognised by the naked eye ; yet, notwithstanding their distinctness, they perfectly cohere and unitedly fulfill the vegetative functions of the plant. Intermediate between all the cells of the thallus, as well as the germinal organs, is a transparent, gummy substance called lichenine, which binds the whole together, and gives elasticity and comparative toughness to the several parts of the thallus when moist. This gummy matter, evident-

ly, has a close connection with the development of the spores; hence, it concentrates and lodges in large quantity in the hymenium of the apothecia, which, when fresh, often presents the appearance of a small clot of jelly. The presence of lichenine constitutes a point of difference between the medulla and paraphyses of Lichens, and the hyphoid parts of fungi. The hypha and paraphyses of the latter, are generally brittle, and non-elastic; and

FIG. 32.

they dissolve away in a solution of hydrate of potash. But those of Lichens are thicker, and more flexible, and do not readily dissolve in the said solution like the filaments of fungi. On the ground of this difference, Dr. Nylander says: "No fungus is present in the formation of Lichens.

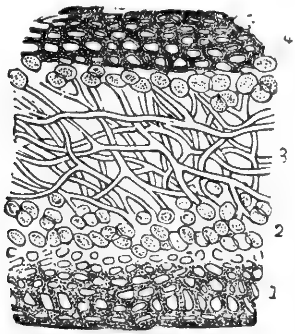


FIG. 33.

This is demonstrated from their very first beginnings; for the spores and primary filaments of germination at once show themselves to be of a lichenose nature." * Beside the three layers of cells already described as constituting the thallus, there is, particularly in crustaceous Lichens, a hypothallus. This is the first vegetation of the germinating spore, which underlies the thallus: and, eventually, from the increasing growth above it, becomes a dead mass. It is generally of a black or brown color, though sometimes it remains white. It will be often seen bordering the thallus, or protruding through it; or, if scattered, filling up the intervening spaces.

The "biological action" of the Lichen-thallus is mostly superficial. It does not increase in thickness beyond a certain point; but it grows upward, or outward from a common centre, according to the form it assumes. The outer portions of the thallus are consequently always the younger. It is not an uncommon thing in foliaceous species, to see the centre of the thallus—the oldest part, entirely decayed and gone, while the periphery still adheres to the rock or tree, and grows on. The centre of vegetative action in the thallus, is undoubtedly in the gonidial cells. They are the chief agents in the growth of the plant. These green cells, says Nylander, "originate in the lower portion of the cortical stratum, and are enclosed in the cells of that stratum, and subsequently, as the development of the same stratum progresses, the gonidia are observed in a free condition." * In their activity, the gonidia frequent-

* *Vide* Grevillea, Vol. VI, p. 44.

* *Vide* Grevillea, Vol. VI, p. 44.

ly burst through the cortex, and appear upon the surface of the thallus in clusters, called SOREDIA; or scattered over it like green dust, when the plant is said to be in a pulverulent condition.

The color of Lichens is very varied and changing. This is greatly dependent upon the place of growth, and surrounding influences. There are many shades of color, but few direct and primary colors,—browns and greys predominate. Green ranges from dark olive to a pale greyish or bluish-green. Yellow, from orange-red and lemon to cream color and white. Brown changes from pale into chestnut and black; and grey ranges between white and black. These colors are due to the gonidia, and the contents of the cells of the cortex or outer stratum of the thallus.

(*To be continued.*)

—o—

Some Phenomena in the Conjugation of Actinophrys Sol.*

BY J. D. COX.

In the latter part of last winter the opportunity occurred of making some consecutive observations upon this Rhizopod in an infusion in which it appeared in considerable numbers, and some of the phenomena are so curious as to seem worthy of record.

These phenomena more particularly relate to the conjugation of the animalcule; but before describing them, I wish to note one or two points, which have reference only to the general form.

Prof. Leidy, in his late work on the Rhizopods, gives his opinion that the rays of the *Actinophrys* are simply gelatinous pseudopodia, of the same substance as the body, and without any solidified skeleton. The evidence for this he finds in the bending of the rays, under the force of a current, like grass in a rivulet. I have frequently observed this bending, but when it occurs under the influence of a current in the water, or of a passing animalcule of another kind, it has been greatest near the tips of the rays, and seemed consistent with a more or less perfect solidity in the parts near the spherical body. But, what seemed conclusive, I have noted instances in which, by the rush of a *Daphnia* against the *Actinophrys*, the greater mass and impetus of the crustacean has broken the rays near their base, leaving them at right angles to their normal direction.

Again, when the *Actinophrys* passes into a condition, which I shall refer to a little further on, and which I have described as the opaline, the rays, in some instances, show a marked appearance of being dissolved and not simply absorbed or retracted. In some cases when the animalcule suddenly collapsed, the rays were left as granulated remains of what they were, dissolving in the water separate from the mass of the body, much as if they were spicules of crystal-sugar or some substance of similar solubility.

By this, I do not mean that the ray was altogether of this character, for the gelatinous covering was also made manifest: first, by a rapid retraction, or current, on its surface, by which the more minute objects of its prey were drawn toward the body of the animalcule, and second, by a similar outward motion by which the ejecta were carried away from the body.

When, in passing into the opaline condition, the animalcule becomes more transparent, a ring is seen near its centre, which does not correspond to the ordinary appearance of a nucleus, as seen in the infusoria, but has more the appearance of a small inner sphere, such as is seen in the endoskeleton of some of the polycystinæ, and the rays appear to reach through the sarcode of the outer body and to connect with this. I will not speak of this as proved, for the translucence of the animalcule never becomes transparence, and definite assertion

* Read before the Microscopical Section of the A. A. A. S., at the Cincinnati meeting.

would be rash. I will only say that so many phenomena point to the existence of an endo-skeleton consisting of two concentric reticulated spheres with rays, partially solidified, but soluble, that I accept this as the probable anatomy of the creature.

The extent to which solidification has gone, and the degree in which it is limited, seems to me to be indicated by the movement of the rays near the contractile vesicle when this expands and collapses. As the vesicle grows large like a great blister on the side of the animalcule, the rays on either side slowly widen their angle, and on the collapse they quickly approach each other, retaining the stiff, rod-like character, and their true line of projection from the centre of the spherical mass.

It has sometimes been stated that the rays of *Actinophrys* cross each other and grasp the prey ; the movement being figured as if the rays were analogous to the spines of *Echinus* and movable from the surface of the body. I have looked for something of this sort with great patience, and have seen the animalcule capture living things, times almost numberless, but have never seen anything like the process described. The radial swinging of the rays when the contractile vesicle collapses is the nearest approach to it, and this, in the case of two Actinophryes in conjugation, will, when the contractile vesicle is near the junction of the two bodies, cause the rays of the two to cross each other on that side. In the capture of prey, however, the process, in all the cases I have observed, is the following :—

If the captured object is minute when compared with the captor, its motion is instantly arrested when it comes in contact with one of the rays. In a moment it slides inward toward the body, when a glairy and true amœboid pseudopod is extended from the *Actinophrys*, irregular in form, but approximately funnel-shaped. This encloses the prey as in a capsule, which is then slowly drawn into the body of the captor, which assumes its regular outline. In some cases the food is apparently found distasteful, and is ejected again before being completely swallowed.

If the captured object is large, as a rotifer or a vorticella, the process is different. A vorticella will be enveloped by a large capsule, often larger than the body of the *Actinophrys* itself. In this extemporized stomach the food will be seen as a granulated, spherical mass, surrounded by the transparent capsule till digestion is completed, when the ejecta will pass out through the capsule, and the *Actinophrys* will resume its usual form. During the process it will have the general outline of the double form, as seen in conjugation, except that the rays will be seen only on one of the lobes, the other looking like a large, hyaline cell of equal size, but an excrescence on the animalcule.

In the case of carapaced rotifers, or large diatoms, the prey is more completely received into the body of the animal ; but this has been so well figured in the ordinary books of reference, that I will not delay upon it. The point I desire especially to note is, that in all these processes I have detected no movement of the rays, except such as were plainly mechanical and fully accounted for by the movements of the body in which they were planted. They, together with any connected endo-skeleton which may exist, are forced aside to make room for a diatom, etc., but I could observe nothing akin to spontaneous or voluntary movement.

The powerful stinging or benumbing effect of the rays of *Actinophrys* was exhibited in cases like the following. A *Rotifer vulgaris*, moving across the slide by doubling itself like a measuring worm, came in contact with the animalcule and, being evidently hurt, made violent efforts to get away. In these, the hinder part of the body seemed to have lost

its power to take hold, and whilst the general activity of the body was convulsively increased rather than lessened, its tail constantly slipped back and a rapid series of doublings of the body gave it no headway. If it happened to get beyond the rays, it recovered its normal motions in a few moments. A *Chætonotus larus*, swimming with its peculiarly strong and graceful motion, struck the rays, and the hinder half of the body became instantly limp and helpless, being utterly without power of motion. The rest of the body seemed strong as usual, and kept up the most violent contortions. In this case, also, if the animalcule got away, its powers were restored in a few moments. Another very striking instance was that of the *Trachelocerca olor*. Swimming with its enormously long and swan-like neck extended, it struck one of the rays near the head. The head and part of the neck shrunk like wax melted in a flame, so complete and instantaneous was the shrivelling and loss of form. Cases of similar kinds were constantly occurring, and as the animalcules named are usually larger than the *Actinophrys*, the phenomena impress the observer with the extraordinary power exerted.

CONJUGATION.—The phenomena of conjugation may be considered either as to the exterior form or as to the results. First, as to form. Two individuals approach each other by a slow, sailing motion, as if merely drifting. Sometimes this continues till the rays having crossed each other, the bodies come in contact and coalesce by the same imperceptibly progressive movement. At other times amœboid pseudopodia are put forth before the contact, and one or more narrow necks connect the two spheres while they are yet separated from each other by one-sixth their diameter.

Usually the union proceeds through a dumb-bell shape till the diameter of the connecting part is about two-thirds that of the lobes. In a period varying from a quarter of an hour to several hours the separation begins, the process being now reversed, the Actinophryes stretching apart till they are connected by a thread almost as fine as the rays. This breaks, part of the thread is absorbed by each, and the two are once more completely distinct. During this process the rays of each lobe radiate from its own centre, and the faint central ring continues visible in each.

Claparède and Lachmann speak of a conjugation of three Actinophryes being observed at once. Leidy mentions it also. In my notes of the series of observation now related, this complex conjugation has occurred between five and six specimens, and in one instance nine were involved, though in this last they did not form one complex mass. A brief description of a few of these cases may be instructive.

Case 1.—Nine Actinophryes were observed grouped near each other, and when first seen three (Fig. 34, *a*, *b*, *c*) were in conjugation in one group, two more (*d*, *e*) in another, two more (*f*, *g*) in a third, and two

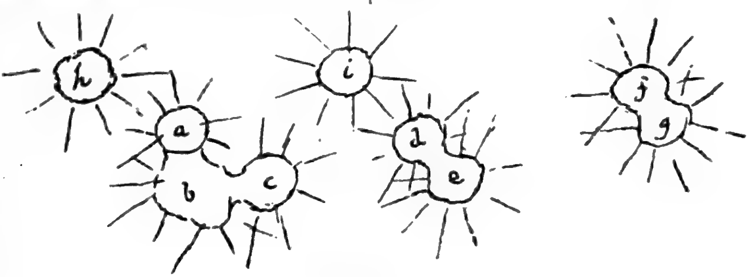


FIG. 34.

others (h, i) were floating separately. That marked i slowly approached d, e, and d stretched away from e as if attracted by i. In a similar way a began to leave b as if drawn toward h, and c to move toward d, e. At the end of the first hour the situation was as shown in Fig. 35. In another half

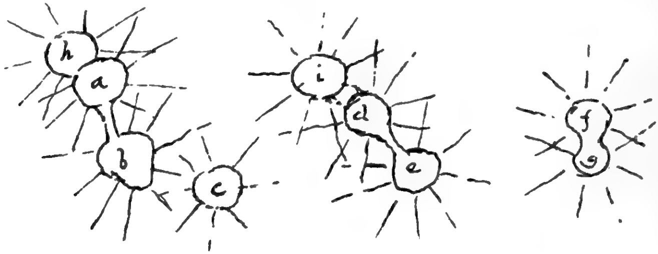


Fig. 35.

hour conjugation had taken place between a and h, and between d and i; f, g remained nearly as at first, and c and e were separate. Fig. 36 shows the

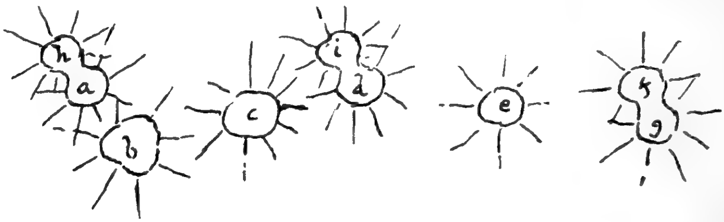


Fig. 36.

general position at this time. An hour later, e drifting toward f, g, that pair separated, f approaching e. So, c approaching d, i, they also separated, as did h, a. The whole nine were now single again, and the lateness of

Fig. 37.

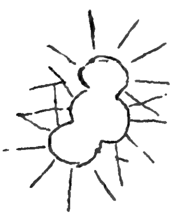
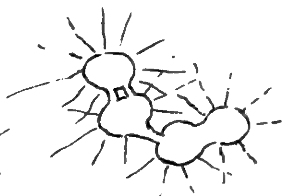


Fig. 38.

Fig. 39.



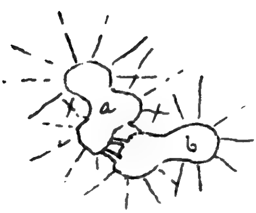


Fig. 40.

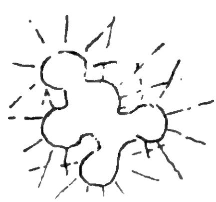


Fig. 41.

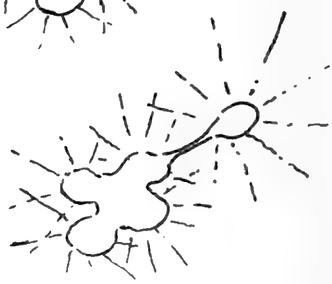


Fig. 42.

the hour prevented following the observation further.

Case 2.—A group of conjugated Actinophryes was noted, in which three lobes with rays proceeding from three centres indicated the union of three animalcules of considerably different size (Fig. 37). Later in the evening another slowly approached and was gradually united to them. Half an hour later a fifth approached, and after a time became connected with the mass by two rather large pseudopodia or filaments, and the process seemed to be arrested there (Fig. 38). Next morning the conjugation had gone no further with the new comer, but fission had begun in the original mass, as shown in Fig. 39. At noon another large specimen had approached the group, and by evening it had united with the portion marked *a*, Fig. 40, whilst the union between the subdivisions *a* and *b* was then by two filaments, each group being pretty well consolidated, though showing its lobes and rays centering in them. In the evening of the second day the whole had become more closely connected, as shown in Fig. 41. Next morning (third day) one of the group was stretching away from the rest, and continued the fission until it was only connected by a long neck, as shown in Fig. 42. The rays of the lobes seemed to be more vigorous than ever, reaching away four or five times the length of the diameter of the several lobes. The whole group had become opaline in color, the masses appearing to be divided into cells larger than before, with small, highly-refractive, colored bodies in these, moving with a swarming motion resembling the Brownian movement.

The fission of the one lobe from the mass went slowly on to completion, but hardly was the connection between them broken, when both parts collapsed and fell to sudden ruin. The rays of the larger mass fell together into brushes at the two sides, and those of the smaller did the same, these breaking up in granules and dissolving like solid matter, and not being retracted or running into the principal masses (Fig. 43, *a*, *b*). The contents of the masses floated away in irregular small por-

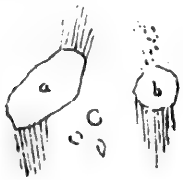


FIG. 43.

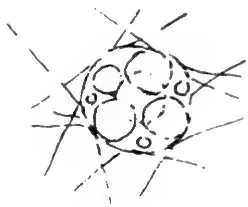


FIG. 44.

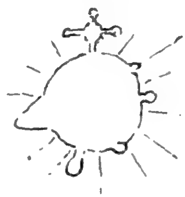


FIG. 45.

tions of protoplasmic substance, each containing two or three of the minute opaque granules above mentioned. These passed out of the field whilst I was watching the final stages of the decay of the principal masses which soon showed nothing but a small patch of amorphous granular debris.

Moving the slide so as to follow the direction which the smaller bodies had taken, I soon came upon what seemed to be these, having the same general appearance as to size and color, and containing the small colored granules. As I had not been able to follow them continuously, for the reasons above stated, there is, of course, a possibility of mistake in recognizing them again. But I had had the slide under examination for several days, and, with the familiarity with its contents thus attained, felt no doubt myself as to the identity of the bodies. Some of these were nearly spherical, some pyriform ; all seemed unicellular. After about half an hour,

fine rays were visible about these bodies, and they assumed the form of a young *Actinophrys*. In this earlier stage there was much resemblance to small *Amœba radiata*, but the development of the different specimens left no reasonable doubt that the *Actinophrys* has this appearance in its earlier stages of growth, and this is confirmed by subsequent observations to be noted.

A fact which appears to me important is this: that I was not able to trace fission in any specimen beginning with the single spherical individual. In all the dumb-bell forms, whether the neck were thicker or smaller, the lobes had each its own center from which its rays projected, making two or more radial systems; and, though I watched with patience for an instance of such beginning of fission in a single specimen, I have never found it. On the other hand the cases of conjugation were extremely numerous, and were traced in very many instances through the whole process to ultimate fission again. In the cases in which this subsequent separation took place, the several individuals did not lose their identity in the union, but the case remained one of conjunction as distinguished from complete coalescence. The ray-systems of the individuals and the central circle of each, remained throughout. All the cases of apparent fission which I observed were, therefore, precisely such as occurred when conjugation had taken place before; and though dumb-bell forms were constantly met with, which I had not traced through previous stages, they all, for aught that I had seen, might most naturally be regarded as cases of conjugation.

In some instances there was evidence tending to show that complete coalescing might follow conjugation, the body then going into the opaline state which I am about to describe, but I prefer to treat this as doubtful till confirmed by more thoroughly traced examples.

THE OPALINE CONDITION.—The *Actinophrys* was frequently met with in a condition which I have referred to as opaline, and it frequently was seen to pass into this condition after conjugation and subsequent separation. The whole body assumed a bluish, milky hue, and appeared divided into spherical cells of varying sizes, the number of these gradually diminishing and the size increasing. The rays became less numerous, smaller, and disappeared. In some cases before doing so they lost their radial direction and fell across each other like sponge-spiculæ (Fig. 44). If we suppose a partly solidified endo-skeleton to be absorbed before the solid parts of the rays, the successive phenomena would be intelligible, and this occurrence is part of the evidence bearing on that question of structure. The large opaline cells were much more transparent than the animalcule had appeared before, so that it was now practicable to focus up and down through the body, passing from the upper to the lower cells in turn. In the usual condition of the *Actinophrys*, everybody knows that this is impossible, though the animalcule is colorless. In these opaline cells are seen very small, highly refractive granules, very nearly opaque but highly colored, red and green, which kept up the active movement before mentioned as resembling the Brownian movement. When the rays had disappeared, and sometimes before they were quite gone, the body seemed every way more plastic than in its usual condition, totally losing the firmness or rigidity which then marks it. Its surface sprouts into gemmæ more or less persistent, some of these taking the form of a central body with several radial arms, others being more like pseudopods of amœboid character, club-shaped and of varying rounded outline (Fig. 45). In the cases I observed, although some of these seemed at times as if almost severed from the parent body, I did not see that separation occur, and

the protruding parts were after a considerable time (from a quarter to half an hour) retracted again. I was disposed to attribute this to lack of aeration in the growing slide, as I saw, under similar circumstances, fission begun in *Trachelocerca*, and not carried to completion, the animalcule resuming its original form as if not having vigor for the attempted process.

In another case of an *Actinophrys*, which had been traced into the opaline condition, the plasticity went so far that a churning movement was seen within it, almost as marked as the periodic movement seen within rotifers. In one instance the whole body had the appearance of a sac to which the churning motion gave change of shape, making it partly roll over on the bottom of the slide. In this case upon purposely agitating the water by pressing the cover-glass with a needle, the animalcule gradually resumed its regular rotundity, and after a time showed faint and thin rays again.

In some instances when the animalcule was watched through the changes leading into the rayless, opaline condition, it finally collapsed, its contents making only a mass of fine granular matter, in which I saw no subsequent motion or life, but only the ordinary appearance of decay and death. In others, however, the evidence of separation into a brood of young was as strong as in case 2, detailed above.

In several examples, soon after conjugation and subsequent separation had taken place, say within fifteen or twenty minutes, a single small rayed specimen, of the size and appearance of those already described, was found in close proximity to the mature individual under observation. It happened that these appeared on the under or upper side of the animalcule, so that the process of gemmation, if such it was, was not seen in the cases in which conjugation had been watched. In one case, when a single *Actinophrys* was under the glass, no knowledge being had of its preceding history, there was the apparent excretion of a small mass which moved quickly out to the end of the rays and floated off. Its regular appearance attracted attention, and, keeping it under observation for half an hour, it had distinctly put forth rays and precisely resembled the young so often referred to.

This record of observations is offered as a contribution to the life-history of the *Actinophrys*, without insisting too strenuously upon the conclusions to which they point. I have given the points in which the continuity of observation was broken, so that no more close connection of sequences in the phenomena may seem to be asserted than actually occurred, and that appearances needing verification may attract the attention of other observers. They point distinctly to two modes of reproduction; one, by single gemmation after conjugation, the other by segmentation of the parent into a brood of young after passing through the opaline condition described.

I purposely neglected examples which seemed to become encysted as my method of manipulation did not afford the means of long-continued preservation of the specimens. The apparatus I found most convenient was a plain slide and cover-glass, which, when not under observation, was laid across the top of a small dish of water, a narrow shred from an old handkerchief connecting the edge of the cover-glass with the water below, and supplying the moisture by capillary attraction. The only limit to the preservation of the slide in the growing condition was the deposit of salts from the water by evaporation, which after a time became sufficient at the edge of the cover-glass to interfere with aeration. A single slide was, however, kept under observation for periods varying from a week to a fortnight.

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Note on the Use of Wax in Dry Mounting.

Notwithstanding the general condemnation of wax as a cement for covers in dry mountings, it is doubtful whether the objections urged against its use, are altogether valid. I have had rather more than my share of experience in unsuccessful mountings of this class. During the past five or six years, I have been engaged upon the problem of the exact subdivision of any given unit into equal parts. Whatever success I may have gained in this direction has, I suspect, been somewhat more than counterbalanced by the deterioration of the ruled plates through the condensations which have formed under the covers.

I have lately collected quite a large number of these plates for the purpose of studying the characteristic defects of different kinds of mountings. As the result of this study, I have reached the conclusion that, for the most part, the primary cause of the condensations which form under the covers, is the moisture remaining upon the glass after the operation of mounting. No matter how thoroughly a glass slide may be rubbed, if it is immediately held over a flame a certain amount of moisture will appear.

The evaporation from certain kinds of cement, without doubt aggravates the difficulty, and probably this is, in some cases, the independent cause of "sweating."

Nearly all of the slides examined were prepared in the following way: First, the cover-glass being held in position upon the slide by a clip, the moisture was expelled by heating. After the glass had become sufficiently cooled, small bits of white wax were placed around the edge of the cover-glass. The blunt point of a heated piece of metal was then passed slowly around the cover, and the melted wax flowed under it, far enough to hold it in position. The larger number of the slides prepared in this way were found to be well preserved. When, however, rings of cement were turned upon the slides, the protection was in almost every case less perfect. In every case in which shellac with anilin coloring was used, condensations on the under side of the cover-glass were found. The covers of several slides were removed, and in no case was there any sweating found upon the surface of the slide.

About eighteen months ago, my attention was called to the use of sheet gutta-percha rings for dry mounting. My first experience with these rings was not altogether satisfactory. It is now evident that I did not, at first, apply sufficient heat to expel all of the moisture between the cover and the slide.

After an experience of several months, I am convinced that slides prepared in the following way, will remain in a perfect state of preservation for any length of time. Use gutta-percha rings having a thickness of about one five-hundreth of an inch, and a diameter about one twentieth of an inch less than that of the cover-glass. Hold the cover in position, upon the ring with a light clip while the gutta-percha is being melted by a gentle heat. If too much heat is applied at first, the ring will lose its normal shape. After the gutta percha is thoroughly melted, the slide should be heated sufficiently to expel every particle of moisture from under the cover. While the slide is hot apply white wax to the surface, the melted wax will run under the cover and will be stopped by the ring. After covering, the wax can be removed from the surface of the glass with turpentine.

I shall esteem it a favor to be informed of any case in which a ruled plate mounted in this way, has failed to remain in good condition.

Wm. A. Rogers.

Harvard College
Observatory.
Sept. 9th, 1881.

How to Measure Objects.

So many microscopists find difficulty in making measurements with the microscope, that we have deemed it worth while to describe the simplest process with some care.

An eye-piece micrometer is invaluable for work of this kind, and the simplest form is the best. A disc of thin glass with a series of lines ruled upon it, every fifth and tenth line being longer than the others, placed within an ocular in the focus of the eye-lens, forms the most convenient and cheapest arrangement, and one sufficiently accurate for ordinary purposes. The thin glass does not materially affect the definition, and it may remain in place ready for instant use. It is advisable to place it in the "B" eye-piece. The lines may be ruled about one one-hundredth of an inch apart, and they should be short and distinct. Measurements should be made in the centre of the field. When the value of the divisions has been determined for each objective, the figures may be arranged for ready reference, as shown in the following table, which is a copy of one we have had in constant use for a long time.

Objective.	Draw-tube.	Micras μ	Inch.	Inch.
$\frac{2}{3}$	4	13.3	$\frac{1}{1910}$	.00052
	6	11.9	$\frac{1}{2110}$	.00047
	8	10.9	$\frac{1}{2333}$	.00042
$\frac{1}{5}$	4	3.75	$\frac{1}{6900}$	.00014
	6	3.36	$\frac{1}{7366}$	.000135
	8	3.1	$\frac{1}{8050}$	.00012
With double nose-piece attached.				
$\frac{2}{3}$	8	10.0	$\frac{1}{2500}$	.00044
$\frac{1}{5}$	8	2.9	$\frac{1}{8695}$	.000115

The first column gives the focal length of the objective. In case of higher powers it would be necessary to give the figures for the collar-adjustment in several positions, but for an ordinary fifth the definition is good enough for measuring without changing the adjustment.

The second column gives the position of the draw-tube, which is graduated in centimetres. Practically, it is not worth while to give the figures for the different positions of the draw-tube, as it is advisable to always use the latter in one position. To use this table we bring the object to be measured into the middle of the field, and count the number of divisions in the eye-piece micrometer that exactly cover it. Suppose we use a ⅔-inch objective, and find that a filament of an alga measures just 4½ divisions. Then the true diameter is $13.3 \times 4.5 = 59.85^{\mu}$ or $\frac{4.5}{1910} = \frac{1}{425}$ of an inch, or $.00052 \times 4.5 = .00234$ of an inch.

To determine the value of the divisions of the eye-piece micrometer in terms of the stage-micrometer, focus the latter by screwing the eye-lens out or in until the lines are clearly defined. Then focus the lines of the stage-micrometer, and determine the number of divisions of the former that are equal to one division of the latter. Suppose the stage-micrometer is ruled in thousandths of an inch, and that nine divisions in the eye-piece are equal to two divisions on the stage, or two one-thousandths of an inch. Then $9 \div 2 = 4\frac{1}{2} = .001$ of an inch, and one division $= .001 \div 4.5 = .00022$ which, in vulgar fractions, is $\frac{22}{100000} = \frac{1}{4545}$.

To obtain the value in micras (thousandths of a millimetre, written thus: 0.000,001), it is desirable to use a stage micrometer with lines giving hundredths of a mm. instead of thousandths of an inch. But without such a micrometer it is a simple matter to make the calculation from the results obtained as above. Thus, one division was found to represent .00022 of an inch. One thousandth of an inch is equivalent to 25.34^{μ} (more accurately 25.399772), hence 1 division $= .2222 \times 25.34 = 5.57^{\mu}$.

We have been thus particular in describing this simple process, be-

cause many persons who have not been accustomed to using micrometers regard it as a troublesome proceeding. We are told in the books to make one division of the stage-micrometer correspond exactly with a number of lines in the eye-piece, which can be done by changing the magnification by means of the draw-tube. The object of this is to make a certain number of divisions equal to .01 or .001 of an inch. But practically it is a useless waste of time, for it is of no consequence to us, for example, whether four, or four and a half, or four and a quarter divisions represent a thousandth of an inch; what we want is the value of one division.

Thc Huyghenian eye-piece is good enough for all practical purposes, although the Ramsden ocular is, in some respects, better. The Jackson eye-piece micrometer is preferred by some to the simple ruled cover-glass, because it is provided with a screw movement to adjust the lines to the object, but this can readily be done by the stage movements, and the disc of glass resting on the diaphragm of the ocular is never in the way, while it is protected from dust.

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The Internal Stellate Structures of Plants.

Mr. Cox in his criticism of my remarks on the Internal Stellate Structures of the Nymphæacæ, published in the September number of your JOURNAL, makes the following statement:—

"One thing, however, seems to me beyond doubt, that in the leaf of "*Nymphæa* or *Nuphar* the principal "part of the internal hairs are planted in the uppermost parenchymal "layer."

This assertion I can not let pass without challenge.

After examination of a great number of recently made preparations of the white, yellow and pink varieties of the plants in question, I am unable to discover anything which would go to show that the "internal hairs" are planted in the upper parenchymal layer.

Those Microscopists who have, by chance, come in possession of some of my preparations of *Nymphæa*, will be able to decide by vision the merits of the question at issue, and without vision it cannot be decided by discussion. The stellate structures have their starting point in the perenchymal layer next below the epidermis; some of the branches row upwards to the epidermis, where, when by it arrested in their elongation they divide in two, and when the branches do not traverse the layer completely, they remain pointed.

The epidermis may be removed, or what amounts to the same thing, the parenchymal layer may be removed from the epidermis without a single star remaining attached to the epidermis; the external hairs of plants cannot be removed in that manner from the epidermis: they are part of it.

I would further call the attention of observers to the fact that the vascular system is quite sparingly represented in the leaf of the plants under consideration, and it requires a long search to discover traces of it in sections of the petiole. Some homologues or equivalents must necessarily exist; the stars and the elongated fibres offer themselves as such, without, in my opinion, straining the argument.

J. KRUTTSCHNITT.

EDITORIAL.

AMERICAN SOCIETY OF MICROSCOPISTS.—Dr. George E. Blackham, the President of this Society, has issued a circular to the members, the purpose of which is to enlist the earnest coöperation of the members in making the meeting at Elmira a success. We have no doubt but that meeting will be a good one, and, for the satis-

faction of the energetic members of the Elmira Society, we hope it will be.

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The "Congress" Turn-table.—Sometimes there is much in a name. Last month we inadvertently referred to the turn-table manufactured by Mr. Bulloch as the "Congress," but Messrs. J. W. Sidle & Co. have reminded us that they make the "Congress," while Mr. Bulloch makes the "Volute." We beg pardon for the blunder; but as Mr. Bulloch makes the "Congress" microscope, why doesn't he make the "Congress" turn-table also? And as Messrs. Sidle & Co. make the "Acme" microscopes, why do they not make the "Acme" turn-tables?

Perhaps this is one of the things no man can find out.

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Charles A. Spencer.—Charles A. Spencer is dead. Probably in the beautiful town of Geneva, where he lived, scarcely any, except a few personal friends, were aware of how much the scientific world is indebted to the ingenuity and persevering labor of Mr. Spencer. He was, in truth, a pioneer in the work of perfecting the compound microscope, and for almost fifty years he has been closely identified with the improvements in the manufacture of microscope-objectives in this country. So far as we can learn, he was the first to make a notably good American objective, although some objectives were made here before his time, and even in his first attempts he far excelled the European makers. It was under Mr. Spencer that Mr. Robert B. Tolles learned the art of making objectives, for which he has acquired a reputation fully equal to that of his instructor.

It seems almost incredible that fifty years ago scarcely a dozen compound microscopes were to be found in this whole country, and yet in the year 1847, when Mr. Spencer made his first instrument, the only persons in this city who possessed microscopes were Dr. C. R. Gilman, who had one by Chevalier; Mr. John Frey, who had a Pritchard; and Dr. Alonzo Clark and Dr. John Torrey. The stand owned by Mr. Frey is now in the possession of Prof. Doremus, of this city, and the Chevalier belongs to Dr. F. A. P. Barnard, the President of Columbia College.

About the year 1847 Spencer visited New York City, and there saw Dr. Gilman's microscope. He remarked that he could make a better instrument, and Dr. Gilman ordered one. When it was finished Spencer brought it to New York; but on the way he stopped at West Point, where he visited Prof. Bailey and showed his new microscope. This instrument included a safety-stage, two oculars, three objectives—a $\frac{1}{3}$, a $\frac{1}{7}$, and a $\frac{1}{16}$-inch—a lieberkuhn for the $\frac{1}{3}$-inch, and a polariscope. It was modeled upon the Chevalier plan, but was rather smaller than the instrument by that maker. In a letter to Dr. John Frey, dated Canastota, N. Y., October 21st, 1847, from which we are enabled to quote by the courtesy of Mr. Frey, Mr. Spencer describes his first interview with Prof. Bailey in the following language:—

"Now, between ourselves, I did *not* make as good an instrument (in the highest power I mean) for Dr. Gilman as I *know* I can make. I used the Swiss flint with the intention of beating the foreign instruments with their own materials—with the design of replacing the highest power by one of my best at a subsequent day. * * * I wished to get, moreover, as correct an idea of the capacity of the foreign instruments as possible—aiming to make Dr. Gilman's instrument as nearly the standard of the best as I could judge, and knowing that Prof. Bailey's *Navicula hippocampus* test would prove the matter well, I called upon him. * * * I had some misgivings, of course, as to the resolution of the *hippocampus*, and told Prof. Bailey so. * * * I

then set up my instrument and showed him, as the first object, the scales of the *Podura*. He almost instantly exclaimed, with warm earnestness, 'I am sure that will show the *hippocampus*.' I replied that I feared not, as I had not one of my best highest powers with the instrument. Prof. Bailey insisted upon finding the object on the slide, and the instant his eye caught it he exclaimed: 'It shows it beautifully—this is a perfect treat.' I then looked at it, and must confess almost instantly lost my reverence for the 'English test-object *par excellence*.'"

Besides resolving the *N. hippocampus*, which was then the most difficult test-object in use, the new objective revealed markings on numerous other frustules which Prof. Bailey had not succeeded in resolving by any other objective.

The statements of this letter were fully endorsed by Prof. Bailey in a letter to Dr. Torrey; he pronounced the microscope "decidedly superior to Chevalier's." Among the advantages claimed by Mr. Spencer for this instrument, was an increased angle of aperture for the objectives—the $\frac{1}{4}$-inch having an angle greater by about one-half than the Chevalier, and the higher power nearly double that of the corresponding one of that maker. Also the field was larger in the Spencer instrument—the power of 350 had a field more than double that of the power of 325 by Chevalier.

This microscope immediately attracted the attention of scientific men, and it was acknowledged that Spencer's objectives were superior to all others. A short account of the instrument was given in the *New York Literary World* for October, 1847, and a more complete one was published in the *American Journal of Science and Arts* during the next year.*

No doubt much of Mr. Spencer's success is due to the conscientious care with which all his work was done; but it should not be forgotten that he was an enthusiast in his work, and therefore able to overcome many obstacles, so, when he found that he could not obtain such optical glass as he desired, he began experimenting in the manufacture of glass, and for many years he used glass of his own production.

About the year 1850 (or 1851) Spencer made a $\frac{1}{16}$-inch, which he said had an aperture of "as near 180° as can be obtained," and this was regarded as a great triumph for the American optician, who had already proved that a limit of 135°, which had been fixed by some, was far too low. Mr. Spencer's later work is so well known that we need not allude to it here.

Charles A. Spencer was born at Canastota, N. Y., in the year 1813. He was educated at the Cazenovia Academy, from which he graduated; afterwards he spent one year at Hobart College. He lived at Canastota until about six years ago, when he went to Geneva and became associated with the Geneva Optical Company, but soon separated from that firm, and in company with his two sons produced objectives which made the name of C. A. Spencer & Sons famous throughout the world. But failing strength rendered him incapable of steady application to his work; during the past few years he did little more than superintend the labor of others, and perhaps the latest products of the manufactory were mainly due to the skill and close application of his son Herbert.

Mr. Spencer died at his residence in Geneva on Wednesday evening, September 28th, 1881. He was modest and always allowed his work to speak for itself—his reputation rests upon what he has done not upon what he has said. His death is sincerely mourned by many friends.

Looking back over the short period of fifty years, we can almost say that

* Second Series, Vol. V, 1848.

this comprises the whole history of the use and improvement of the compound microscope in this country; and it is not easy to realize that all this is embraced within the recollection of men now living.

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MONOCHROMATIC LIGHT FOR RESOLUTIONS.—Some time ago M. Eugene Mauler addressed a communication to the *Société Belge de Microscopie*, concerning the use of a blue cover-glass for mounting diatoms, claiming that it facilitated the resolution of tests. We translate the following from the *Bulletin*:—"In order to obtain monochromatic light to facilitate the resolution of difficult tests, M. Mauler employs a blue cover; this method, simple as it is practicable, is destined to render good service to diatomists. The assembly was convinced of the value of the plan; a trial made with a $\frac{1}{18}$-inch homogeneous immersion objective of Zeiss yielded very good results—the resolution of *Surrirella gemma* was easily accomplished."

In another letter M. Mauler wrote:—"According to the more or less perfect quality of the objective, there is more or less advantage in using these blue covers; thus with an objective No. 5 of Seibert, which gives me a certain amount of color, the result is surprising, but with an objective No. 7 by Hartnack, the effect is less noticeable, because that objective is very well corrected."

It would seem, therefore, that the advantage of the blue cover-glass depends upon the correction of the objective, and not merely upon the color of the light it transmits.

M. Mauler has kindly presented to us a slide of *Grammatophora marina* mounted under a blue cover, and while we hesitate to express any decided opinion as to the advantage to be derived from the blue glass without further trial and comparison, we can say that the light is very agreeably modified, and the striæ of the diatoms are very clearly defined with an inferior objective.

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ACCESSORIES.— Last month we promised some observations about accessory apparatus for the microscope. Just as there is a tendency to purchase large and expensive stands, there is an idea that a large number of accessories is requisite for microscopical work. But this is by no means true. However, there are a few which are really useful, and it is about some of these we intend to write.

Not many years ago a costly achromatic condenser was thought to be a very valuable piece of apparatus. To-day such condensers are seldom used, and they are quite unnecessary. For giving intense illumination for high magnification they are not so good as much cheaper appliances, and for oblique light the more simple forms of immersion condensers are preferred.

For routine work with medium powers (up to a $\frac{1}{10}$-inch for example) no condenser is necessary, but, nevertheless, a simple form of condenser with a low angle and provided with suitable stops is very useful. In our opinion the Webster condenser is an excellent form. It has been our custom to keep a Webster condenser constantly on the stand. It affords a ready means of regulating the illumination as different objectives are employed, or when the camera-lucida is to be used, and it is an excellent substitute for a paraboloid, although the dark-ground effects obtained are not quite equal to those of the paraboloid.

For intense illumination, such as is required when very high-power lenses and deep eye-pieces are used, probably an ocular with an achromatic eye-lens, such as a Kelner eye-piece is preferable to anything else.

A polariscope is certainly useful, but it is more used for fine displays

of color than as aid to study. Nevertheless, there are many cases in which it is quite invaluable, as for instance in studying rocks and crystals, and it reveals many details of structure which would otherwise be unnoticed. The prisms should be large, so as to admit sufficient light for brilliant effects, and when the prisms are crossed the field should be quite dark.

A camera-lucida is quite indispensable. A good free-hand drawing from the microscope can be made without the use of a camera-lucida, but even the trained eye is liable to err in delineating objects in this way, and this instrument guards against mistakes from that source.

A bull's-eye condenser mounted on a stand, an animalcule cage and a compressorium will complete the list of articles that we need mention in this connection.

It is seldom that the practical microscopist will feel the need of any other accessories, except for producing brilliant effects of illumination for the mere entertainment of himself or friends.

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THE USE OF DEEP EYE-PIECES.—Some time ago a correspondent desired an expression of our views concerning "the theory now advanced by some microscopists that the true way is to provide one's self with two or three wide-angled and first-class objectives and 'eye-piece them up' to the required amplification, instead of obtaining the power from the objective."

We have never regarded this proposition as worthy of serious consideration, or we should have discussed it in these pages long ago; but as our correspondent may be one of many who would like to hear the other side of the subject, and as we have seen allusions made to it of late, indicating that the minds of some microscopists are still unsettled concerning it, we offer a few words for their consideration. If the reader will turn to page 89 of the current volume of this JOURNAL, he will find the statement that "there is a certain amplification that can easily be obtained by lengthening the body-tube, or by deeper eye-pieces, which will render visible to a normal eye, every detail which the particular objective can resolve." But the resolving power of an objective is limited by its angular aperture, hence there is a direct relation between the angular aperture of any particular objective and the amplification necessary to reveal the details which it can portray. In other words, the angular aperture determines the limit of resolving power. The amplification only separates the images of the particles or lines resolved, so that the rays proceeding from them shall enter the eye at an angle sufficiently large for the eye to distinguish them.

As an illustration, suppose we have two objectives, a $\frac{1}{4}$-inch of 110°; and a $\frac{1}{10}$-inch, also of the same angular aperture. With the same ocular we would have, with the two objectives, an amplification of 200 and 500 diameters respectively. Now, an objective of 110° angular aperture will resolve about 79,000 lines to the inch. If the ocular employed renders those lines visible with the $\frac{1}{4}$-inch, giving a power of 200 diameters, the $\frac{1}{10}$-inch giving 500 diameters would not reveal anything more. But, by the use of deeper eye-pieces, we could readily obtain a power of 500 diameters with the $\frac{1}{4}$-inch, and then we would have an exact counterpart of the image given by the $\frac{1}{10}$-inch—no other detail being revealed than by the lower eye-piece, but all made larger. The question then naturally arises: if the $\frac{1}{4}$-inch, by deeper eye-pieces, can be made to do the work of the $\frac{1}{10}$-inch, of what use is the $\frac{1}{10}$-inch?

In the consideration of this question it will be observed that the angular aperture has no bearing upon it whatever,—but in passing it may be remarked that it is only since the time

of wide angular apertures that the habitual use of deep eye-pieces to obtain amplification has been advocated, and even now it is only for "wide-angled and first-class objectives," as our correspondent states. The explanation is simple enough,—as the aperture is increased the objective admits more light, and the use of deeper eye-pieces is thereby rendered possible. It is not that any advantage has been observed in the use of deep eye-pieces and comparatively low-power objectives. We are willing to admit that, within reasonable bounds, the definition is as good in one case as in the other. But theoretically this cannot be true, and practically there is greater fatigue to the eye when deep oculars are used, and it is the practical aspect of the question that most interests us. A few words, however, about the theory. It has been clearly shown and already stated in this JOURNAL (p. 88), that the imperfections of the objective are so much greater than those of the ocular that the latter may be disregarded, and that it is useless to attempt the correction of the former by carefully corrected oculars. It follows from this that the use of deep oculars magnifies the defects in the objective-image, and for this reason it is better to use shallow oculars and well-made high-power objectives. But lest any person should be led to a wrong inference from this remark, we should say that it is only in very exceptional cases that an objective of a less focal length than the $\frac{1}{25}$ of an inch is of any use, and even then it should be of a moderate angular aperture; for extreme apertures a focal length of $\frac{1}{12}$ of an inch is, in our opinion, quite high enough for any purpose. The practical side of the question is easily disposed of from the testimony of experienced investigators, and also from other considerations. It seems that the fatigue of the eye occasioned by the use of deep oculars would naturally result from the necessarily more careful adjustment of the eye to the focal point, and from the greater angular convergence of the cone of rays which enters the eye for a given amplification. When a writer asserts that he can distinctly observe certain points of structure with a low-power, wide-angled objective and a deep ocular, we do not doubt the statement; but probably the same details could be continuously studied with less strain to the eye, with a higher power objective and a lower ocular. As regards the wide angular apertures under deep eye-pieces, it should be remembered that the greater the angle the less perfect the correction of all the rays from the centre to the periphery of the field, hence the greater the defects in the image to be revealed by the deep ocular. It can now be readily understood why we would prefer to work with a $\frac{1}{10}$-inch of a given aperture up to the limit of its resolving power, with a low ocular, rather than with a $\frac{1}{4}$-inch of the same aperture, with a correspondingly deep ocular.

Since the above was written we have received a letter from a gentleman whose name is well known to the readers of this JOURNAL, but as the letter was not intended for publication, we suppress the writer's name, and quote a passage bearing upon this subject:—

"I was much pleased with your article on 'Objectives' in your last number. Great claims were made for the high angled, homogeneous-immersion lenses,—that they gave better definition, and allowed the use of much higher power eye-pieces. Well, I ordered the best Tolles could make, and I have tried it to my satisfaction on bacteria, and I know that it will not bear deep eye-pieces, nor is there any very perceptible improvement in definition over a water-immersion of moderate angle by the same maker. The short working-distance I think is a most decided objection."

This is the testimony of a man who is engaged in original investigations.

———o———

Bacteria.—Dr. Charles S. Dolley has published a translation of an article by Dr. Ferdinand Cohn, on "Bacteria, the smallest of Living Organisms." It is in the form of a pamphlet of thirty pages, with one lithograph-plate. We have already directed the attention of our readers to Dr. Magnin's work on the Bacteria, translated by Dr. Sternberg, which is the most useful book we have in English treating of this subject, but for the microscopist who merely desires a general knowledge of the forms he meets with, sufficient to enable him to say whether they are *Bacterium*, or *Bacillus*, or *Vibrio*, etc., we can heartily commend this pamphlet.

The distinctions made by the author result in six genera, as follows :—

Micrococcus ball, or egg-shaped,
Bacterium short, rod-like,
Bacillus straight, fibre-like,
Vibrio wavy, curl-like,
Spirillum, short, screw-like,
Spirochæte long, flexible, spiral.

The rapidity of their multiplication is astonishing. It has been calculated that a single one will give rise to a progeny of 16,770,220 in a one day, and in two days the number will be 281,500,000,000 ; in a week the number could only be expressed by figures of fifty-one places.

The importance of these minute organisms should not be under-estimated ; Dr. Cohn has indicated their role in effecting decomposition in these words :—

"The whole arrangement of nature is based on this, that the body in which life has been extinguished succombs to dissolution, in order that its material may become again serviceable to new life. If the amount of material which can be moulded into living beings is limited on the earth, the same particles of material must ever be converted from dead into living bodies in an eternal circle ; if the wandering of the soul be a myth, the wandering of matter is a scientific fact. If there were no bacteria, the material embodied in animals and plants of one generation would, after their decease, remain bound, as are the chemical combinations in the rocks ; new life could not develop, because there would be a lack of body-material. Since bacteria cause the dead body to come to the earth in rapid putrefaction, they alone cause the springing forth of new life, and therefore make the continuance of living creatures possible."

The pamphlet concludes with some speculations concerning the origin of life upon the earth, in which it is suggested that the germs of bacteria may have come to us from the cosmic dust, and thus the bacteria became the first living organism on this globe, from which all other forms have since developed.

——o——

Pond-Life.—We have recently received from Mr. A. D. Balen, of Plainfield, N. J., who, as already mentioned in these columns, is arranging to supply microscopists with living specimens, several bottles, the contents of which have been very interesting. At the present time we have some of the beautiful zoophyte *Pectinatella magnifica*, which has been growing in a small bottle for several days. This zoophyte grows in gelatinous masses of more than a foot in diameter, but it is useless to endeavor to keep the large masses in jars. Small colonies, about a quarter or half of an inch in diameter, attached to water-plants, should be selected for this purpose, and they will live very well in a sufficient quantity of water. Under a low power objective one of the small colonies is a very beautiful object. The double row of tentacles belonging to each individual, covered with active cilia which produce strong currents in the water, drawing the food to the animals, are arranged on a horse-shoe shaped disc, which is a characteristic of the order Hippocrepia. Under a ⅔-inch objective the cilia on the tentacles are readily seen. It is said that this animal is not found in Britain.

Among other striking objects we have an abundance of *Melicerta*, which is among the most beautiful of the Rotatoria, and *Stentor* is occasionally found. Spherical masses of jelly, attached to submerged stems, of a light green color and varying from very minute particles to over a quarter of an inch in diamter are abundant. They are algæ of the genus *Chætophora*. When examined under the microscope they are found to consist of a colorless mass of jelly, within which is a mass of green filaments, radiating from the centre to the surface of the sphere, in a very regular manner. By crushing them the mode of branching can be studied. Many other interesting specimens were found in this collection. At the last meeting of the New York Microscopical Society, Mr. Balen exhibited a large number of beautiful living objects, which added much to the interest of the meeting. *Conochillus volvox*, a spherical colony of active rotifers, was shown in perfection, and the beautiful floscule with its long radiating appendages; *Pectinatella* spreading its ciliated tentacles which sparkled brilliantly on a dark field, and another zoophyte, *Plumatella ; Lacinularia ; Volvox globator* swimming about and illuminated by oblique light, *Corethra plumicornis* with the gorgeous colors developed by polarized light, all these were shown and greatly admired, both by members and visitors. Living *Bacillaria paradoxa* was also shown by one of the members of the society.

CORRESPONDENCE.

To the Editor;—In the September number of the American Monthly Microscopical Journal, an article by C. M. Vorce, F. R. M. S., calls attention to the "Destruction of Acari by a Fungus." Last spring the drinking water of this city had a marked fishy smell and taste, and contained the crustacean *Cyclops*, dead and alive, in abundance; those which were dead were permeated by a mycelium, appearing very coarse under a ¼-inch objective, restricted to the animalcule; were the fishy odor and taste attributable to the defunct crustacean?

N. G. Keirle, Sr.

[The odor and taste to which our correspondent alludes, are supposed to be caused by the decay of certain algæ, and it hardly seems possible that it could come from the *Cyclops*, as suggested. It may be that the crustaceans were killed by the impurity of the water, after which the fungus developed on the dead specimens. —Ed.]

NOTES.

—It can hardly be considered as creditable to any person to circulate false reports about the standing of persons in business. Reports have been circulated in some sections of the country, by whom we do not know, calculated to injure the business of Messrs. J. W. Sidle & Co. We take occasion to say that we are assured, by one of the members of that firm, that the reports which have occasionally reached us from distant quarters, are utterly without foundation, and that their business is prosperous.

—Prof. W. A. Rogers, of whose recent serious illness we regret to learn, has nevertheless accomplished some good results with his ruling machine. He has now a decimetre, upon a steel bar, divided into 10,000 equal parts, and beside it, four inches, also subdivided into 10,000 equal parts.

—J. J. M. Angear, A. M., M. D., Professor of Pysiology and Pathology in the College of Physicians and Surgeons at Keokuk, and President of the Microscopical section of the Iowa State Medical Society, has accepted the Editorship of the Microscopical and Pathological Department of *The Western Medical Reporter*.

—A striking illustration of the amplification obtained by a microscope, is given in the pamphlet by Dr. C. S. Dolley, noticed in another column. The passage referred is as follows :—

"The strongest of our magnifying lenses, the immersion system of Hartnack, gives a magnifying power of from 3,000 to 4,000 diameters; and could we view a man under such a lens, he would appear as large as Mont Blanc, or even Chimborazo,

But even under this amplification the smallest bactina do not appear larger than the points and commas of good print."

We have not verified this calculation and do not vouch for its accuracy.

—We are indebted to M. Julien Deby, for two pamphlets in which he treats of the microscopical appearances of the valves of diatoms, showing that "although it is often difficult, at first sight, to interpret the appearances presented by certain diatoms viewed as transparent objects under the microscope, an attentive examination of the details will, nevertheless, give the interpretation of all the facts observed." This he proceeds to demonstrate by means of diagrams, illustrating *Nitzschia* and *Amphora* in various positions. The pamphlets are reprints from the *Annales de la Société Belge de Microscopie*.

—The Société Zoölogique de France has published the report of a "Commission de nomenclature" appointed by the Society to present a series of rules applicable to the nomenclature of organisms. The report is a most excellent one, and it should be in the hands of every naturalist. It was adopted by the Society, and the rules for nomenclature have been briefly summarized in the space of two and a half pages, so that any person can easily follow them.

—Mr. C. M. Vorce has found that the ground coffee sold in Cleveland, the greater part of which is ground in that city, contains a considerable proportion of starch, which he was inclined to regard for a long time as a mixture of pea and bean starch. But further investigation, without the aid of the microscope, has shown that only peas are used there, in the sophistication of the ground coffee, and these are bought by the car-load.

—The first part of the "Catalogue of the Diatomaceæ" is at last ready, and will soon be in the hands of subscribers. No one has regretted the delay in the completion of this part more than we have ourselves; but the work is of a very difficult nature, and accuracy is only to be attained in it by very close application and extreme carefulness. We trust that subscribers will show their appreciation of the efforts we have made to put this valuable work into a permanent form, by promptly remitting the price, which, with the number of subscribers we now have, will not quite pay the cost of publication.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted—First-class mounts of double-stain vegetable preparations in exchange for first-class insect preparations.
H. S. WOODMAN,
P. O. Box 87, Brooklyn, E. D., N. Y

Well-mounted Histological and Pathological slides in exchange for other first-class slides.
W. H. Bates, M.D., 184 Remsen St. Brooklyn, N. Y.

Wanted—first-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.
M. A. BOOTH, Longmeadow, Mass.

Wanted—Human Muscle with Trichina, in exchange for well-mounted slides of vegetable drugs.
OTTO A. WALL, M. D.,
1027 St. Ange Ave., St. Louis, Mo.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Section of Brain, stained, showing Tubercular Meningites; also Carcinoma Cerebri. Please send list.
L. BREWER HALL, M. D., 27 South 16th Street.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoœ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides*.
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Fine injected specimens of kidney, tongue and liver, also very fine slides of human tooth, prepared according to the method of Dr. Bödecker, showing the protoplasmic net-work between the dentinal canaliculi, in exchange for first-class histological and pathological slides, or other good specimens.
J. L. WILLIAMS, North Vassalboro, Me.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

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An Introduction to the Study of Lichens.

BY REV. W. JOHNSON.

(*Concluded from page 183.*)

Having, though but in a very limited way, touched upon the chief features of the Lichen-thallus, we must now endeavor to convey an idea of its reproductive system. Lichens are said to have many modes of reproduction. Körber enumerates six. Two by spores and four by gonidia. But without accepting that statement, the

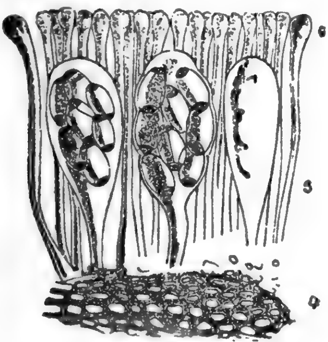

Fig. 46.

Lichen undoubtedly has a secondary, or indirect method, of reproducing itself, by its green cells or gonidia. Still, whether the gonidial cell alone can produce a perfect plant, that is, a plant which will bear fruit and develop spores, we have not yet seen authenticated. The proper and normal way of fructification in the Lichen, is by sporidia. These are developed in a special organ adapted for their formation, protection, maturity and dispersion, when ripe. This organ is denominated the apothecium. (Gr. *apothēkē*, a storehouse or repository.) It is always found upon the surface, or attached to the margin of the thallus. It may be sessile — resting upon the surface; innate — sunk in the thallus; stipitate — on little stalks, or surmounting the top of podetia. These latter are cylindrical and vertical prolongations of the thallus, crowned with a cuplike cavity, on the toothed margins of which grow the apothecia, as in *Cladonia.* In some cases the cup is substituted by globose fruit, singly or conglomerate. The apothecium assumes many different shapes on different plants. It is typically round and flat, or slighly concave — when it is termed scutellate. Sometimes it rises up from the margin of the thallus like a target, as in *Peltigera;* then it is peltate. At other times, it is oblong and furrowed; when it is called lirellate. It also appears like a little wart upon the thallus, then it is verrucose. Besides these, there are other forms. The structure of the apothecium is the most complex part of the plant; and it is beautiful in its arrangement, as well as efficiently adapted for its purpose of maturing and protecting the spores. The apothecium consists of two parts: an excipulum and a nucleus, called the hymenium. The excipulum is the outer covering, or envelope of the apothecium. It is seen encircling, or more or less enclosing the fruit. When it is of the same texture and color as the thallus it is termed a thalline excipulum. But when

it differs from the thallus, and partakes more of the color of the nucleus, it is a proper excipulum. The hymenium, or thalamium, is the centre of the fruit organ, and is easily recognized by its color and gelatinous appearance. It embraces the paraphyses, asci and spores. The paraphyses (6 Fig. 46) are long, slender, cylindrical, hyaline, cells, or filaments; swollen at the apices into the shape of a club, where they are also frequently of a dark or pale color. They grow upright or vertical from a bed of cells, known as the hypothecium, (4 Fig. 46), and stand like corn in a field, only closer together. Their apices are glued into a solid mass, and form what is called the epithecium, or disc of the fruit. The direct function of the paraphyses is not clearly understood; but it is, without doubt, to subserve the spores. By their agglomeration, they retain around the asci, if they do not secrete it, a large quantity of lichenine, which helps the nourishment of the young sporidia. They also hold up the asci in a vertical position, when being full of spores, they would otherwise fall down upon the hypothecium; and when the asci and spores are ripe they act as a sort of spring upon them, caused by the expansion and contraction of damp and dry weather. The spores are thus, by pressure, expelled into the air through the disc or epithecium; when the wind wafts them on, to grow in new spheres. The asci or thecæ (5 Fig. 46), are large vesicles or sacs, growing upright among the paraphyses from the hypothecium. They are in shape oblong, pyriform, linear or clavate; but always tapering off at the base. They are closely pressed by the paraphyses, from which they differ by being broader and inferior in length. The spores are formed and matured in these sacs; and when ripe, by the lateral pressure of the paraphyses, or the internal pressure of the spores, or from both, the ascus ruptures at the apex, and the spores, are liberated The spores (Gr. *spora*, a seed), Fig. 46, is the reproductive germ. It is formed in the ascus from a protoplasmic-lichenine matter. When mature, it consists of a cell having an inner and outer wall, termed respectively, the endosporium and episporium. It is frequently divided by septa into two or more cells. The spores are generally eight in number, in each ascus; but some of the larger spored forms, as *Pertusaria*, produce in the spore-sac four, two, and sometimes only one spore, while on the other hand, in minute spored species, they are innumerable. The form and color of the spores are very much disversified. They range from globose to fusiform and acicular. That is, from round to spindle and needle-shape. Their color is from a pale greenish or yellowish tinge, to a dark olive or deep brown.

Composed of these several parts, the apothecium constitutes the female organ of the fructification, the spores of which are fecundated by the minute bodies next to be described; but how, or in what way, this fecundation is affected, has not yet been discovered. The fecundating bodies are termed spermatia. They are very minute rod-like, or oval organs, varying in length and breadth; and are sometimes bent or curved; they are uncolored and transparent. These organs are produced in small cavities, sunk or immersed in the Lichen-thallus; and opening on its surface by a small pore. These cavities or cysts are called spermogones. (Fig. 47).

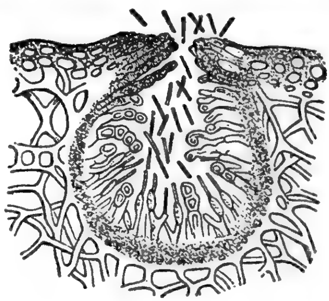

Fig. 47.

They sometimes require a lens to discover them ; but, on some thalloidal forms they are plain and prominent. As, for instance, the laciniæ, of certain Ramalinas, and the fronds of *Ricasolia amplissima.* The interior of the spermogonic cell is composed of a number of delicate, elongated filaments, all growing from the walls of the vesicle, and at once projecting and converging into the centre of it. These filaments are denominated sterigmata (Gr. *sterigma*, a prop or support) from the fact that they bear the spermatia. The sterigmata are sometimes simple or articulate and branched, and they bear the spermatia on their sides or apices. The contents of the spermogones, like those of the apothecia, are truly lichenose, being filled and bathed with lichenine. Perhaps, we should mention another minute organ found upon the Lichen, and named pycnides. These externally resemble spermogones, and only a microscopical examination can distinguish them. They differ, however, in their internal growth. Instead of sterigmatic filaments, they contain simple, short, thickish stalks, or stoutish cells, called basidia, which generate and bear on their apices stylospores. These are pyriform or oval bodies, something like ordinary spores. The function of pycnides, like that of spermogones, is still very much shrouded in mystery, and until this is understood, we cannot truly know the real difference between them. They are illustrated by Fig. 48.

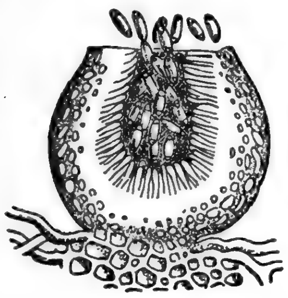

Fig. 48.

We have already hinted that the Lichen has no axis and no root. Therefore it does not nourish itself from the soil, or place of growth. It is an aerial plant, and what the water with its solutions is to the Alga, the damp atmosphere is to the Lichen. The whole plant imbibes nourishment alike, and its growth is, therefore, much affected by the purity, dryness, or humidity of the air. A polluted atmosphere is destructive to Lichen growth, while a flourishing condition of these plants, is a sure indication of the purity of the surrounding aerial medium. On account of their spongy, cellular nature, Lichens are strongly hygrometric. After being in the herbarium for years, on the application of moisture which they greedily absorb, they will freshen up and appear almost as bright and green as when first gathered. While humidity promotes their growth yet they are capable of enduring great drought. The crustaceous Lichens are of very slow, and frequently very long, growth. Some are said to grow for hundreds of years. They cover, and emboss in grey and gold, the rocks on our highest mountains ; to which they cling so closely, that no storm affects them. The foliaceous plants, contrary to the crust-forms, attain their highest development at low altitudes, and in shaded places. Some of the softer and less thalline plants grow to maturity in a short space of time. I gathered myself, *Odontotrema longius* (Nyl.), in considerable quantity on an old rail, near Asby, Cumberland, in the autumn of 1879. In the same month of last year (1880), I visited the same spot, and upon the old cuttings of the previous year, upon the very knife marks, I found the same plants regrown. No thallus was visible, but some of the apothecia, when examined under the microscope, were fully developed. This growth of the Lichen had been made in one year.

The habitats of Lichens are almost all objects on the surface of the earth.

They grow abundantly on rocks, old stumps, exposed tree roots, the withered fronds of ferns, on mosses, sheep's dung, mortar, and some have been found on glass. They are natives of the whole country side.

> "With such a liberal hand has Nature flung
> Their seeds abroad, blown them about in winds."

Although our remarks partake more of the character of hints than full statements, yet, on account of their length already, we must at present omit noticing the uses and applications of Lichens, with their classification and geographical distribution; and we must proceed to give a few suggestions on the method of studying this group of plants. Now, the thing of primary importance in the study of any subject, is a definite object. To fritter away our time over a score of different things, answers no purpose beyond a momentary gratification in our own mind. It leaves no permanent results, nor deep sense of satisfaction. We must select where the subjects before us are so many. Our selection should be made with due regard to the tastes and idiosyncrasies of our own minds, and the favorableness of our circumstances for the pursuit. With definite aim and concentration of powers, we are sure to work to some good end. Further, it is not desired that any student of Nature should content himself with being merely a collector, classifier, or herbarium-maker; but that he should seek a more intimate acquaintance with things. Knowledge is only sound and good in proportion as it is profound; for it is only when we know the nature of things, that we can assign them their proper place in systems, or increase their useful application in daily life. In the study of Lichens, the first thing needed is a text book, or some source where we can obtain a sufficient knowledge of the plants, as to become a starting point for our own observations. The meagre notice taken of Lichens in most Manuals of Botany, is of little or no use. Hitherto, it has hardly seemed to come within the aim of books of that class, to acquaint any one with our Cryptogamia; and Lichens, more then any other group of plants, have been ignored or neglected by them. The best book, and the only suitable one we have at present for a beginner in Lichenology, is "A Popular History of British Lichens," by Dr. W. L. Lindsay. This book is simply and well written, also beautifully illustrated. It costs about seven shillings. After that, "A Manual of British Lichens," by W. Mudd, is a good work, but it is scarce. The chief book on the subject is "The Lichen-Flora of Great Britain, &c.," by Rev. W. A. Leighton, 3d Ed., 1879. Price *21s.* This last work can only be used after some acquaintance with the subject. In addition to the literature mentioned, the student will find great help from the possession or access to a series of dried specimens.

After the reading and study of the text book, plants may be gathered. For this purpose you may have to go a considerable distance from home; but begin collecting nearest home first. As you acquaint yourself with the plants nearest your own immediate neighborhood, then widen your area of search. Select a fine day for collecting. A little damp in the air will be an advantage; because some gelatinous and foliaceous Lichens growing on stones, if very dry, are apt to break and crumble in gathering. When in that condition, we have sometimes sprinkled them with water from an adjoining stream; and in a minute or two, they have yielded beautifully to the broadish point of the knife beneath them. Specimens should always be gathered, if possible, in fruit; and as near complete as can be. Preparations should be made for this out-door work. Put on clothes which will neither trouble nor deter you from thrusting yourself into any corner. Let your boots be such as will cross swampy ground, or dip into a stream without discomfort. You will

also require a pocket lens; a hammer, and two or three mason's chisels. If you carry only one chisel, and have to face hard rocks, during the first fifteen minutes you may find yourself half helpless for the rest of the day, by the turning or breaking of your chisel point. Crustaceous Lichens are gathered by cutting away a piece of the stone on which they grow, and the other forms accordingly. You will further need a botanical box, or small basket, and many of the specimens will require wrapping in paper, to prevent rubbing, in carrying them home. Take particular note where the plants are gathered, so that the locality in a word or two can be written upon the sheets when they are mounted.

On reaching home with your gatherings, the first thing to be done is to press and dry the foliaceous and fruticulose forms. Then mount the whole on slips of paper, with gum or glue. We find nothing to answer this purpose better than a thick solution of gum Arabic, with a few drops of glycerin in it, to modify its brittleness. On each slip of paper record the place where gathered, with date, and collector's name. The plants may now be placed together on one side without danger of confusion, and be brought out one by one for determination or study as you may have leisure and opportunity. In the investigation of Lichen tissues and sporidia, and the determination of species, there will be required a compound microscope, with a magnifying power of from 60 to 400 linear measurement (one-inch and quarter-inch objectives with A and C eye-pieces); also, a double lens for the eye. Some use an ordinary watchmaker's eye-glass. One of these glasses mounted in a pair of spectacle frames, would be very useful for the lichenologist. A small thin dissecting knife, and solutions of iodine, hydrate of potash, and hypochlorite of lime. The making up, with the application of these reagents, are fully described in Leighton's Lichen-Flora. The iodine acts more or less upon the gelatina-hymenea of the paraphyses and asci, turning them blue, yellow, or vinous-red. The hydrate of potash dissolves the gelatina-hymenea, and shows the hymenium more clearly under the microscope, beside swelling the spores and paraphyses up to their full size. The hydrate of potash and hypochlorite of lime are also used on the Lichen-thallus as tests; and, as such, are of considerable value and importance. On account of the chemical elements in the thallus, it reacts in certain colors, or not, on the application of these reagents. This reaction, or non-reaction, is a great help in the determination of species. The method of examining the apothecium or other organ of the Lichen, is to place the plant on the table, then, with the lens to the eye, place the knife on the top of the organ about midway, and cut it straight down. Cut down a second time close to the first, and thus get out a section as thin as you possibly can; place it in the compressor, or upon the glass stage of the microscope, moisten it with clear water, and put on a thin glass cover. Now you may examine the section, and if you have a good cut, you will have all the parts of the apothecium before you. You must now observe the color and form of the hypothecium, the character of the paraphyses, with the color of their apices; also, the shape of the asci, and the number, color, form and septa of the spores. You may now run in a drop of iodine, watch and carefully note the results. After this, run in a drop of the hydrate solution, which will annul the action of the iodine—consequently it must always be used after it, where both are required. This does not generally destroy any natural color, but it will show you, if you have obtained a correct idea of the several points just named above. When you have thus examined the apothecium, and the spermogones if you can find any; and

have likewise observed the nature of the gonidial layer, then carefully group the outer features of the plant. As well as a mark of carefulness, it is a good disciplinary process to write down all the points in examination as you go on, both internally and externally; and, when this is complete, turn to the Manual and look for a description of your plant, under that family, series, tribe, or sub-tribe, to which you have already concluded it belongs. Drawings of the spores, or any part of the plants, should be attached to the sheets upon which they are mounted, and the whole be arranged together in the herbarium, according to their classification. Microscopic slides, neatly mounted and finished, illustrating different plants, are very useful for reference and instruction.

The Lichen-herbarium is usually made up according to the taste and convenience of the parties concerned. Leighton describes his in his Lichen-Flora. If it is intended that the herbarium shall follow the order of the system of classification, then the best way is to mount each species and form, upon a separate sheet of cartridge paper, cut to a convenient size, and in due order arrange so many together, in suitable covers, upon the herbarium shelves. Thus, as fresh or new species come, they can be inserted in their proper places.

The Lichen-Flora of Great Britain, at present, comprises upwards of 1700 species, forms, and varieties; and undoubtedly, there are yet many new species to discover. Here then, is a wide field for activity and enterprise; and we can promise that it is as full of delight and interest as it is wide. But, the morphology, chemical nature, and the relation of Lichens to the atmospheric medium, are yet to investigate. Researches in these departments have been begun, but that is all. These deeper subjects of study though, can only present themselves properly to the mind of the student, when he has mastered the primary elements, and learned readily to distinguish one plant fron another.

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Motion of Diatoms.

The notes on motion of Diatoms published in the April number of this Journal have called out some statements as to similar phenomena noticed by other observers. Among these, few will be found so deserving of consideration as those of Dr. G. C. Wallich, of London, formerly Surgeon-Major in the British India Service. Dr. Wallich is a recognized authority in regard to the natural history of the Protozoa as well as the Diatomaceæ, and his observations in both hemispheres are important contributions to science. Several of his articles are noteworthy for their bearing on the subject of the motive power of diatoms, and we are sure the readers of this Journal will be thankful for references to them.

In the *Annals and Magazine of Natural History* for January, 1860, the latter part of a paper on the distribution, etc., of the free-floating Diatomaceæ is devoted to the consideration of the motive powers of these organisms, maintaining that the motion cannot be due to osmotic forces, but must be ascribed to "the "existence of prehensile filaments, "capable of alternate extension and "retraction, of extreme tenuity, yet of "extraordinary strength and elasti-"city," in virtue of which both the ordinary to-and-fro movements of the diatom-frustule itself, and the motions imparted by it to neighboring extraneous particles or masses of matter are brought about.

Similar views were advanced and supported by Dr. Wallich in a paper read before the Royal Microscopical Society, in December, 1859, and subsequently published in the *Quarterly Journal of Microscopical Science.* This had special reference to the views of Professor W. Smith on the subject, as stated in his "Synopsis of British Diatomaceæ."

Again, in a paper on "The Relations between the Development, Reproduction and Markings of the Diatomaceæ," read before the Royal Microscopical Society in January, 1877, by the same author, the osmotic theory of motion was again discussed, and the belief expressed that careful observation would in due time reveal the presence of motile filaments; just as the actual presence of the previously unseen but long suspected flagellum in *Bacterium* was at last detected by Messrs. Dallinger and Drysdale.

Still later, at the close of a paper entitled "Are the Desmids and Diatoms Simple Cells?" published in the *Popular Science Review* for April, 1877, the same views are repeated in relation to the general question involved in the various well-known extra-frustular appendages observable in certain genera of diatoms.

In this connection, there is here given a copy of one of Dr. Wallich's original notes of observations on the motion of *Nitzschia closterium*, made in 1860, from which his conclusions were drawn.

"In some material obtained Feb. 2d, 1863, from the Aquaria at the Zoological Gardens, I found a long, beaked variety of *Nitzschia closterium*, length $\frac{1}{83}$ of an inch = .0120. Diameter at centre of valve $\frac{1}{2800}$ inch. Diameter of beak, $\frac{1}{15000}$ inch. Specimens of this *Nitzschia* moved about very rapidly and laid hold, during their progress, of masses of foreign matter—apparently vegetable debris—many times the weight of the diatom itself. These they pulled along, now and then retaining their hold and towing the masses along behind them at a considerable distance from the extremity of the beak. In one example the mass was nearly $\frac{1}{6}$ of the total length of the *Nitzschia*, and at least a third as broad as its broadest part. This mass was moved halfway across the field of vision, and several times tugged after the diatom. The most remarkable feature being the ease with which the long, slender organism turned round, sometimes with a steady, gliding motion, sometimes with forcible jerks, as if there was resistance or pressure to be overcome. To my mind it was quite impossible to witness what took place without feeling perfectly convinced that the foreign body was in some way laid hold of by a motile filament or may be several filaments, given off from the diatom, and in the case in question serving the purpose of a tow rope. I had many years previously arrived at the conclusion that such filaments exist in the Diatoms generally, although unable to detect them with the aid of Ross's $\frac{1}{12}$ and $\frac{1}{16}$ most perfect objectives. It is utterly absurd to suppose that such movements as I witnessed could, by any possibility, be due to osmotic action. See my paper on 'The Distribution and Habits of the Free-floating Pelagic and Fresh-water Diatomaceæ' published in *The Annals and Magazine of Natural History* for January, 1860, where the question of these movements, etc., is fully described."

J. D. C.

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Koch's Demonstrations in the Germ Theory.*

Among the many interesting facts brought forward and the discussions held during the Congress, none surpassed, if indeed any equaled, the work done by Dr. Robert Koch, of Berlin. He first showed some of the new methods of cultivation, which surpass in beauty and simplicity, as well as in usefulness, anything that has yet been done in this way. He began to study the growth of pigment bacteria on boiled potatoes, and soon discovered that, as the organisms were there growing on a firm substratum, they did not become mixed up with each other or with accidental contaminations, and he could always find a spot where the bacterium was pure. Any organism intro-

* From the *Medical Herald*.

duced accidentally grew only where it fell, and thus a pure cultivation from a pure part was always possible; on the other hand, if these organisms had been grown in a fluid, the introduction of another form would have rendered them impure forever. Dr. Koch exhibited specimens of *Micrococcus prodigiosus* which produces a red pigment, and also of the bacillus which causes blue pus, and that which causes blue milk. Other forms of bacilli were shown which, microscopically, were indistinguishable, but which could be at once separated from each other by differences in their mode of growth on solid substances. The advantage of a solid, rather than a liquid, cultivating material being thus apparent, Dr. Koch next turned his attention to the solidification of other cultivating materials, such as would nourish pathogenic bacteria, and he found that by the addition of gelatin to the fluid used, in the proportion of 3 or 4 per cent., a solid cultivating material was obtained, whose power of nourishing organisms was not in any way interfered with by the presence of the gelatin.

Some of this material, being rendered fluid by heating and spread out on a slide, was allowed to solidify; then bacteria could be sown on it, and their mode of growth watched with a low power of the microscope. Thus, a minute quantity of dry earth was scattered over such a slide, and, in a few hours development, could be seen around almost every particle. In this particular specimen seven different sorts of bacilli were present; many of these could not have been distinguished from each other by the microscope, but a difference was at once observed between their modes of growth on the solid substance—some forming round balls, others growing out in a star-shaped manner, others growing in a fine net-work, etc.

In the same way, the number and nature of the organisms present in any given quantity of air, could be estimated. A broad, shallow vessel was filled with the gelatin mixture and exposed for a given time to the air. At every point where an organism fell upon it, growth occurred, and thus the number and nature of the organisms present could be at once ascertained. But, further, as each organism was a pure cultivation, pure flasks could be inoculated from each variety, and thus its further life-history and pathogenic characters could be investigated.

Similarly with water. The material in a test-tube having been rendered fluid, a given quantity of water was shaken up with it until solidification occurred. At every point where an organism was present in the water, development occurred, and thus the number and nature of the organisms present in a given specimen could be at once ascertained.

Dr. Koch also exhibited some of his pathogenic bacteria. Animals which had been killed with anthrax were shown. The fatal nature of the poison was demonstrated; the constant presence of the *Bacillus anthracis*, its mode of growth in the gelatin substance, and its virulent properties after having been grown in it, were all made apparent. The bacillus of mouse-septicemia, which is described in his work, was shown in a similar manner. For several months this organism was cultivated in gelatin-blood-serum, forming a fine, cloudy mass, and retaining its form and other characteristics. A minute drop of this was placed under the skin of a mouse. This animal died in forty-eight hours; and in its blood were numerous bacilli. Another mouse inoculated from this blood also died. In gelatin inoculated with this blood these organisms developed; and after further cultivations with this, the minutest drop killed another mouse. Septicemia was shown in pigeons, rabbits, mice, etc., due to a minute bacillus of peculiar form, resembling in appearance the organism of the *choléra des poules* of Pasteur. The

same sort of proof was given with regard to this organism as in the former case. And, lastly, a form of erysipelas was shown in the ear of rabbits caused by the inoculation of the rod-shaped bacillus of the septicemia of mice; this, sometimes, though not always, killed the animals.

The importance of these experiments can scarcely be estimated at present, but there is no doubt that they show a great advance, and no work has more tended to throw light upon the complicated subject of pathogenic bacteria than that of Dr. Koch. Dr. Koch lays great stress on the value of micro-photography as essential to an accurate record of facts; and photographs, which he exhibited on Friday, were certainly very fine examples of what can be done in this way.—*Medical Times and Gazette.*

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The Abbe Binocular Eye-piece.

[The following abstract from a letter written by the author to his brother, Mr. C. F. Cox, is given, by permission. The eye-piece is described on page 221 of Volume I.—Ed.]

My Zeiss binocular eye-piece came about a fortnight ago, and I have spent several evenings over it very satisfactorily. In fine, it is like the sectional drawings which were given in the *Journal of the Royal Microscopical Society* and in Hitchcock's Journal. It is provided with loose caps which go on over the eye-pieces. One pair of these is pierced with semi-circular openings, and the other with circular ones.

When the caps are turned so that the openings are in the outer half of the eye-pieces, the vision is stereoscopic. When the openings are in the inner half the vision is pseudoscopic. When the circular openings are used the vision is binocular but not stereoscopic. This is the form in which it is useful for high powers. The field is only of the size usual when continental stands are used, and is considerably smaller than that even of Beck's "Popular." The semi-circular openings make a little awkwardness of vision, but one quickly becomes used to it. By reason of the smallness of field this binocular is not so pleasant to use with the low powers as the Wenham. In every other respect it works as well.

With high powers its work is so pleasant and admirable that it is a great delight to use it. I find the best results with central light and Webster condenser, the latter used with a longitudinal slit for admitting the light. In this way I actually found that I could go quite as far in resolution on the test-plate as with the single tube and central light. The Powell & Leland 1/8 resolved all the first 17 tests of Möller with this strictly central illumination. This is more than I have ever done with the same glass and central light. I account for it by supposing that the use of both eyes in this way, with the longitudinal-slit-stop under the condenser, really gives a degree of oblique light by the crossing of the rays. There is a beautiful finish in the definition which makes the result upon ordinary diatoms more satisfactory than any other I have ever had. The partial stereoscopic effect seems to give the markings a degree of relief which makes them sharper and more real than ever before. It seems to me a demonstration of the fact that the dots are areolæ and not spherules. I don't think the beauty of its work with high powers and central light can be understood without seeing it.

With oblique light and high powers I went through the test-plate; but using the Wenham disc-illuminator, I found I could not get the two images to coincide in the case of long shells like Nitzschias. Whether I can overcome this difficulty I don't know. I will try the prism next, to see if there is the same trouble.

On the whole it is a great advance, and goes far to establish my old proposition that a binocular eye-piece is the true binocular for the microscope.

The smallness of field can easily be connected by making the eye-pieces of the English pattern, and when this is done it will be superior to the Wenham method every way. The light is not appreciably less than in the ordinary binocular. It is certainly abundant.

You will understand, then, how I am naturally feeling that my little Zentmayer is now very nearly a model stand. J. D. Cox.

CINCINNATI, Oct. 14th, 1881.

Achromatic Illumination for Low Powers.

My highest objective at present is a Tolles $\frac{4}{10}$-inch, and I am consequently obliged to use high oculars to obtain great amplification when desirable. My $\frac{4}{10}$ has an aperture of 100°, yet even with this tolerably wide angle, there is necessarily a considerable loss of light when the solid eye-pieces are used. To remedy this, I some time ago applied to Messrs. Queen & Co., of Philadelphia, to furnish me with a Kelner "C" eye-piece, fitted with an adapter for my sub-stage, to serve as an achromatic condenser, the form so highly spoken of by Dr. Beale. The condenser came in due time, and after a thorough trial I am very much pleased with it indeed. It is only suitable for central light work, there being no diaphragm as in its prototype, the Webster condenser. By lamp-light, using the quarter-inch solid ocular, it gives with the $\frac{4}{10}$, a clear, brightly illuminated field, as bright as that given by the two-inch ocular when the condenser is removed. The light needs to be diminished a little when using the half-inch solid ocular, which is done by turning down the wick of the lamp. The bright, achromatic light, which seems to bring out details of structure with a distinctness such as I can secure by no other means, being superior to the best results obtained by condensing the light on the mirror with a large bull's-eye. There is a marked decrease of that watery, hazy appearance, generally noticeable when even the best objectives are "strained up" by high oculars. Using the $\frac{4}{10}$ and the quarter-inch solid ocular on a medium scale of *L. curvicollis*, while the definition of the edges of the "exclamation marks" is, of course, less sharp and clean than with the half-inch or lower oculars, yet the result is remarkably good, and the effect is attributable, in a great measure, I am sure, to the character of the light employed. And it is not alone on test-objects that the condenser works well. Upon any object suitable for study with high powers, there is an unmistakable advantage secured by this mode of illumination.

Messrs. Queen & Co.'s bill for the condenser, including sub-stage adapter and three caps with different sized openings, was $8.50, which is considerably less than the price of the Webster condenser, which, I believe, is the cheapest form of the regular achromatic condenser made. And I am of the opinion that when I am the possessor of a still higher power objective, my "Kelner" will still stand ready to help that to do its best work as readily as it does my Tolles $\frac{4}{10}$ now.

A. L. WOODWARD.

Note on the Functions of the Spinal Cord in the Frog.

BY E. A. BIRGE, PH. D.,

Professor of Zoology, University of Missouri.

The experiments described in the following paragraphs were carried out in the spring of the year 1881, at the suggestion and under the direction of Professor Ludwig, in the Phrenological Laboratory of the University of Leipzig. The point to be studied and the methods of work were suggested by Prof. Ludwig, and I am responsible only for carrying out his plans. The work was in continuation of an anatomical investigation which

I had made on the large ganglion-cells of the cord and their numerical relations to the motor fibres.

The fact that irritation of the frog's spinal cord causes titanus is not new, but no attempt had previously been made to exactly determine the portion of the cord concerned in this phenomenon.

The mode of experiment was as follows: The brain of the frog was destroyed and the animal fastened upon a small board, and secured in such a way that its spinal column was firmly fixed. The spinal cord was then exposed throughout its length, especial care being taken not to wound it or to injure the roots of the nerves. Bleeding was also prevented so far as possible. The tendo Achillis was then severed from its attachment and connected by a band to the pen of a revolving drum, on which the movements of the gastrocnemius muscle were thus recorded.

The first experiments were devoted to localizing the tetanus-centres longitudinally in the cord and to investigating whether an irritation of one side of the cord caused a tetanus of the other side. Two modes of irritation were successfully tried—puncture with a sharp needle, and pressure with a blunt one. The first was, of course, much more local in its effect than the second. By beginning to pinch the cord, at, say the origin of the second nerve, and passing backward, no effect was produced on the gastrocnemius muscle or the hind limbs until just at the origin of the seventh nerve. Then a slight tetanus was produced. Beginning to irritate at the hinder end of the cord and passing forward, the posterior limit for this tetanus-centre was found to lie just at the hinder end of the origin of the ninth nerve. Irritation of the region included between the origins of the seventh to the ninth nerves, inclusive, called out a tetanus in the hind leg of greater or less duration. The point of maximum irritability lies near the origin of the eighth nerve.

It was further found (1st), that irritation of the cord on one side produced no effect on muscles of the other side; and (2d), that the larger the area of the tetanus-centre affected, the more vigorous and long-continued the tetanus. Thus pressure with a blunt needle produced much more effect than puncture with a sharp one, and the effect of the latter needle was smaller in proportion to its smallness and sharpness. It was further found that irritating the motor roots of the nerves in the same way as the cord produced only a contraction, never a tetanus.

At this stage of the experiments electrical irritation was tried, but unsuccessfully. The pressure of the electrodes was sufficient to excite the mechanical and electrical effects.

More recent efforts at localizing the centre were then made. First, portions of the cord were cut away by passing through the cord thin pieces of platinum wire, hammered flat, sharpened and polished. In this way the posterior columns of the cord, the sensory roots of the nerves, a great portion of the lateral columns and the posterior zone of the grey matter were removed without affecting the functions of the cord as a tetanus-centre. Attempts at removing the interior columns failed, because it was found very difficult to remove these without at the same time injuring the anterior zone of the grey matter. The method is at best rude and is liable to cause injuries beyond the limits of the portion removed. It, however, showed that this function of the cord was located in either the anterior column of the white matter or in the anterior zones of the grey matter.

It is well known that in the last-named part of the cord there lies, in the frog, a peculiar group of large ganglion-cells, closely united to each other, and probably to the motor fibres. It was natural to regard these as the seat of this function, and new experiments were resorted to in order to locate the point more exactly. In

order to do this the construction of an instrument was necessary, and while waiting for this, ruder forms of the same experiment were made. The frog-board was fastened upon the stage of a microscope, movable by screws in two directions, at right angles to each other. A holder with a needle was substituted for the tube of the microscope, and could be moved up and down by the rack and pinion movement of the instrument. The centre of the cord was brought under the needle, the cord pierced through and the needle withdrawn. The screw was then turned so as to move the frog a short distance to the right or left, and the irritation was repeated. As before, the gastrocnemius was connected with the registering-drum, and the point at which the prick of the needle caused a tetanus was noted. It was found that in all cases in which a tetanus was found, the needle passed through the anterior zone of the grey matter. Inside of this point no effect was found; outside, and especially where the root of the nerve was injured, a contraction occurred, but no tetanus.

The instrument constructed was on the same principle as the one described, but with a divided head to the movement-screws, so that the distance passed over could be measured. The needle was ground flat and placed with the flat surface parallel to the axis of the cord. The experiments were conducted in the same manner as before, except that the frog was moved $\frac{1}{10}$ mm. each time until the whole breadth of the cord had passed under the needle. The effect of each needle thrust was noted. The cord was then removed and hardened in alcohol, imbedded, and sections cut at the points of irritation. A careful camera lucida drawing was then made of the cord and its diameter divided into as many equal parts as there were needle thrusts, which were represented by pins passing through the cord. *In every case it was found that only those punctures caused a tetanus which passed through or grazed the group of large ganglion-cells in the anterior zone of the grey matter.*

Several experiments were then made with cords which were punctured from side to side, instead of from above downward. The result was always the same, and the thrusts passed at right angles to each other, conclusively showed that the small area of the mass of ganglion-cells gave rise to a tetanus when irritated, and that no other part of the cord did so.

One unexplained exception must be noted. The irritation of the anterior commissure sometimes, but not always, gave rise to a tetanus on both sides.

The following conclusions may fairly be drawn from these experiments :—

1st. There is in the spinal cord of the frog an apparatus capable of converting into a tetanus an irritation, which, if applied to the nerve, causes only a contraction.

2d. This apparatus lies in the anterior zone of the grey matter, and more exactly in the cluster of large ganglion-cells there situated.

3d. The tetanus is stronger and longer continued in proportion to the number of cells affected.

4th. Although these cells form a connected ganglion-centre throughout the cord, only those which lie close to the origin of a given nerve can rise to a tetanus-impulse for the muscles supplied by the nerve. The limits of the tetanus-centre for the hind limbs, and for the fore limbs as well, are very sharply marked, both at their anterior and posterior limits.

5th. As a corollary, the motor nerve-fibres probably unite with the ganglion-cells soon after entering the spinal cord.

6th. The tetanus-centres of the two sides are quite independent, and irritation of one nerve causes action in the other. Irritation of the anterior commissure may sometimes excite both to action, but never one.

We thus catch a glimpse of a possible function for an apparatus whose use was before obscure. When directly applied to the ganglion-cells, a momentary irritation can call out long-continued action in the muscles.

It is not impossible, though far from being demonstrated, that their normal function is somewhat similar to this. Perhaps when momentarily irritated, in the normal manner, through the sensory nerves, the ganglion-cells may give origin to a long-continued muscular contraction or series of contractions.

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About Stands.

[The following letter from Mr. Stodder is given a place here, in large type, that no one may neglect to read it. We have referred to it in our editorial column.—Ed.]

In your September number I find an important paper on this subject. So important do I find it that I ask you, in all courtesy, the privilege of saying a few words in controversion of your dicta. "There *can be no doubt* that the time of the large and costly microscopes is passed" * * * "but the experienced worker, whether he be an amateur or a professional man, will surely discard them. Solidity and steadiness can be secured without excessive weight, and the smaller and more compact a stand can be made * * * the better it is. Now, a stand that is sixteen or eighteen inches high is very inconvenient to work with. It is an undeniable fact, which will be admitted by every investigator who has used both large and small stands, that the latter are by far the more convenient. Therefore, we say that the best and most salable stands of the future will be the low stands, not much higher than the common German model."

I like to have one announce his opinion distinctly, even if he does it dogmatically, without arguments or reasons. I ask for the privilege of giving my dissent from such opinions with reasons.

Mr. Editor: Your journal has a wide circulation among the young and novices in science; some of them look to you for advice and your article about microscopes was evidently written for the purpose of giving advice. I deem the advice you have given as quoted above false, pernicious, and misleading. I controvert each and every point that you give as facts, viz.: There is a "doubt that the time of large and costly microscopes is passed." "The experienced worker will" *not* "surely discard them," if he can get one. "Solidity and steadiness can be secured without excessive weight;" this is as indefinite as a piece of chalk. Why not tell your clients what you call excessive weight—6 lbs. or 30 lbs? I claim, from 25 years' use of the microscope, that while 30 lbs. may be excessive, 16 lbs. is not; that 4 lbs. is too light. I believe that there is a general want of information among beginners as to the use of weight in a microscope. It should be so heavy that every needed movement can be effected with one hand without touching the instrument with the other, and not changing the direction of the illuminating ray in the slightest degree. It should be so heavy that little slight accidental touches, which will sometimes occur to the most experienced worker, will not only not upset the instrument, but will not disturb its relation to the light in the least. I have used stands, of noted reputation, so light that the most trifling touch or jar would move them, and no movement of fine or coarse adjustment, of the mirror or draw-tube could be made unless one hand held the instrument still, while the other effected the movement; such instruments are unfit to use. Avoid them. "It is" *not* "an undeniable fact which will be admitted by every investigator who has used both large and small stands," etc. For it is denied as emphatically as language will permit. But directly the reverse is the truth. It is the small, low German stands that are inconvenient. It

is the 16-inch high stand that is more convenient. Holding these views, my advice to purchasers, if they wish to become investigators or true scientific observers, not mere tyros and parlor showmen, is to procure the largest and best microscopes their means will permit, only don't be governed by glitter, lacquer and show; insist on workmanship as near perfection as human skill will permit. Avoid the low, cheap German style if you do not wish to be saddled with an instrument that you will throw aside, give away, or keep as a "tender" as soon as you become a microscopist and wish to push your investigations to their ultimate end.

The whole utility, aim and object of the microscope, its costly construction, its profound investigation of optical laws required for making—*not manufacturing*—its lenses, its varied and ingenious appliances, is to see with. Now, I make this proposition to any and all believers in short, low stands: He, she, or they may provide objects properly mounted from any and all departments of natural history; I will show each and every one of them with a low German stand (Hartnack pattern), with a Jackson pattern, 16-inches high, and with an intermediate size, using the same eye-pieces and the same objectives from a 4-inch to $\frac{1}{25}$-inch, and I will show every object better with the largest stand than with the smallest. To see better is the whole utility of the instrument. But this is not all. With the large stand, an ordinary height of table and chair, the observer can sit in an unconstrained position without straining the muscles of the neck and back with his lungs fully inflated; on the contrary, with the low German stands, his head and shoulders are bent forward, the chest compressed, the muscles on a continual strain and the observer unfitted for good work. One may work for four hours continuously on one slide, with less fatigue with the 16-inch stand than for one hour with the short one. Again, the large stand has ample room for appliances inadmissible or inefficient on the small one, and admits of all the important variations of illumination that cannot be obtained except with such stands.

CHARLES STODDER.

BOSTON, October 12th, 1881.

EDITORIAL.

—In the words of one of our exchanges, "We want everybody who owes us money to pay as soon as possible." These words will apply to a great many persons, who have now received eleven out of twelve numbers of the volume which closes next month. Let each one of these remember that, although he owes only the very insignificant sum of one dollar, the aggregate of such small amounts now due to us from subscribers is quite large. "We want everybody who owes us money to pay as soon as possible."

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—We have to remind the editor of the *Cincinnati Medical News* that he seems to be relapsing into his old habit of reprinting our articles without giving us due credit. We hope the affection has not become chronic.

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NEW AND LITTLE KNOWN DIATOMS.—A valuable contribution, from P. T. Cleve, has been published, in English, by the Royal Swedish Academy, "On some New and Little Known Diatoms," with descriptions of the specimens. It is a quarto of 28 pages and six plates. The diatoms are from several localities; from the Gallapagos Islands, Honolulu, Port Jackson, the Mediterranean Sea and elsewhere. Some of the forms are very curious and beautifully marked.

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EYE-PIECES.—Mr. G. S. Woolman has, very justly we think, objected to the expressions "deep" and "shallow" eye-pieces, as being unscientific and misleading. We intend to dis-

card them from this time forth, and we trust our readers will aid us in keeping them out of both correspondence and ordinary conversation.

In reference to our article on page 196, Mr. Charles Stodder, in a private letter to the editor, writes as follows: "In general I concur with you, but not entirely; you say that an objective of 110° will resolve 79,000 lines to the inch. What is the authority for that? But few of that angle can do that, and some may do much more; and when you come to the crucial test, one observer can see more than another. I always require a higher eye-piece than Mr. Tolles does."

Perhaps we should have stated that 79,000 was the number that could be resolved according to theory. In all cases it should be understood that the necessary magnification for the resolution of a given test is partly dependent upon the eye of the observer.

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Etiology of Malarial Fevers.—In a special report to the National Board of Health, Dr. George M. Sternberg, U. S. A., has given full particulars of his researches in this subject, accompanied by two heliotype plates, and two charts showing the temperature-curves.

The report begins with a presentation of the views of Klebs and Tommasi-Crudeli by short quotations from their memoir concerning the *Bacillus malariæ*, which they claim to be the cause of malaria. Dr. Sternberg criticises the evidence upon which their claims are based; he does not regard it as convincing, nor has he been able to fully indentify the organisms which they have figured and described, but he inclines to the belief that they have included more than one species of plant under the name *B. malariæ*. Dr. Sternberg does not attach great importance to the colored pigment observed by those authors in the spleen and elsewhere, nor to the enlargement of that organ, since the same features may be observed in rabbits which have died from septicæmia. His own experimental researches were conducted at New Orleans, much in the same manner as those of Klebs and Tommasi-Crudeli. An "artificial marsh" was arranged by placing a quantity of mud in tin vessels with perforated bottoms, standing in shallow, porcelain dishes containing water. The organisms from the mud were collected by placing a thin cover-glass lightly on the surface. After twenty-four hours the moisture that was usually found condensed upon it would contain the organisms in a good condition for examination. Culture experiments were also conducted, using a solution of fish-gelatin.

A large number of injection experiments were conducted upon rabbits, which are fully detailed in the report. We fail to see how any person who reads the report carefully can fail to agree with the conclusions of the author. He says: "Among the organisms found upon the surface of swamp mud, near New Orleans, and in the gutters within the city limits are some which closely resemble, and, perhaps, are identical with, the *Bacillus malariæ* of Klebs and Tommasi-Crudeli; but there is no satisfactory evidence that these or any other of the bacterial organisms found in such situations, when injected beneath the skin of a rabbit, give rise to a malarial fever corresponding with the ordinary paludal fevers to which man is subject." However, although the evidence is not strong enough to sustain the opinions of the Italian investigators, it does not follow that the *Bacillus malariæ*, or some other organism, is not the cause of malarial fevers. "On the other hand, there are many circumstances in favor of the hypothesis that the etiology of these fevers is connected, directly or indirectly, with the presence of these organisms or their germs in the air and water of malarial localities." In the blood no indication of these germs can be found, nevertheless the organisms may not thrive in the

blood, but elsewhere in the body they may live and produce their effects.

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Professor C. H. Stowell's New Magazine. — In our July number, page 138, we made a few remarks concerning the magazine recently established by Prof. C. H. Stowell, *The Microscope and its Relations to Medicine and Pharmacy*. The tone of our article was undoubtedly critical, while at the same time it cannot be said that it was either discourteous or unfriendly. We are, therefore, surprised at the savage attack which it has called forth in the October number of *The Microscope*. It reminds us of the sorrowful remark of the generous man who had just loaned his friend ten dollars: "There goes a friend, for ever gone; irretrievably gone." We merely indicated what seemed to us to be the shortcomings of *The Microscope* as a scientific periodical, not indeed because of any personal interest in that publication, but for the credit and dignity of American scientific literature; and for this laudable purpose we have been made the subject of a disgraceful personal attack, which, so long as we allow its unjust accusations and implications to pass without reply, is far more humiliating to the writer than to ourselves. Surely we cannot descend to refute such charges, nor do we expect them to injure us in the least. However, since the Editor of *The Microscope* fails to appreciate the value of friendly criticism, we will now supplement our previous article by two quotations from disinterested persons. The first is from a correspondent who writes as follows:—

"Your notice of *The Microscope and its Relation to Medicine and Pharmacy*, is severe, as it should be. I sent for a specimen copy and I fully agree with your remarks."

The second is from *The Northern Microscopist* (London):—

This is a bi-monthly American magane, and we scarcely have made up our minds whether it is intended as a scientific or serio-comic journal. There are one or two good articles contained within its pages, but very many things we certainly object to. We shall probably abstract for next month a paper, "The Bacteria Fallacy Illustrated," in order to see what is thought of it on our side, but we do not quite see what the following cutting has to do with microscopy, it appears to refer more to the advertising column than to this science:—

"Now that the warm season is with us, bringing its usual discomfort and actual disease, we would call the attention of our professional readers to a remedy which we have used in cholera infantum with marked benefit. Physicians have reported in its favor from every direction. We refer to *Lactopeptine*, the formula of which can be found on our advertising page 17." *

"Maltine," who is a two-page advertiser, has half a page of matter on page 77 devoted to his interests. A microscopical journal seems hardly the place to puff quack medicines. The "Items," too, might be omitted with considerable improvement to the journal.

Usually we are quite apt to say just what we think; but in regard to *The Microscope*, we have been reluctant to express ourselves freely, lest the severity of our criticisms should lead our readers to impute to us some animosity toward its editor, which does not exist. All we have to say is that *The Microscope*, as a pretended exponent of microscopical science, as an American scientific paper, fully deserves and receives our condemnation. The October number contains a rambling, nonsensical letter from a correspondent, who writes under the *nom de plume* of "Grey Beard." On page 114 there is a sensational, and highly improbable, story about Mr. Charles Darwin and Dr. Hahn's discovery of "fossil organisms in meteorites," which discovery, by the way, we have not deemed sufficiently authentic to deserve mention in these columns. Then there are some sensational, very newspaperish articles about adulterations and poisonous articles of food, which should be ex-

* Perhaps it is proper for us to say that we quote the above "puff" free of charge.—Ed.

cluded from any paper having the least pretentions to be scientific. The probably true and the false are so intermingled in these articles that the ordinary reader cannot distinguish between them.

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MICROSCOPE STANDS. — We have not the least objection to being criticised, providing it is done soundly and energetically. It is quite immaterial whether our critic is right or not, if he will only express his views in a sufficiently dogmatic and emphatic manner we will surely print his criticism—for there is such a thing as injuring the force of an argument by unreasonable claims. Mr. Stodder has soundly berated us for what we said about stands two months ago, but, strange as it may seem, we really do not feel like making the slightest retraction. No doubt we are very obstinate, but, *à propos* of M. Stodder's complimentary allusion to our responsibility as an authoritative instructor, we deem it proper to say that nothing goes into the editorial columns of this JOURNAL until it has been carefully considered, and we do not mean to give advice for which we are unwilling to assume all responsibility. To be sure, it may not always be microscopically orthodox—but perhaps our personal equation would not permit it to be so; since we are always looking for the best that is, or will be, and trying to improve upon the perfection that has been. Nevertheless, we cannot allow Mr. Stodder's article to pass without a few remarks, principally to correct some misapprehensions to which it might lead, as to our own words. We have in no place especially commended the German model, but we wrote of "low stands not much higher than the common German model."

We most decidedly object to the style of criticism which permits of incomplete quotations. Mr. Stodder quotes us as saying "the smaller and the more compact a stand can be made * * * the better it is": We said no such thing. Where he has placed the stars we had the words "without sacrificing convenience of manipulation and effectiveness." Mr. Stodder's remarks about weight should not be taken without some consideration. We would say that if a stand is too light to permit the coarse and fine adjustments to be turned without moving the instrument, the fault is in the adjustments more than in the stand. We stated, that low stands are "by far the more convenient" Mr. Stodder says: "the reverse is the truth." Mr. Stodder's challenge does not materially effect our position. It is sheer nonsense to attribute special advantages to a stand of large size, over a properly constructed small one. The fact that an object can be displayed better by a large Tolles stands then by a small Hartnack proves nothing, except that the Hartnack is not properly made for competition of this kind. For a fair criticism, Mr. Stodder must confine himself to the conditions of the question as set forth in our previous article. We did not invite a comparison between the optical effects to be observed on large and small stands as now made. Our text was, the greater convenience of the latter, and the principles to be considered in designing the stands of the future.

NOTES.

—A corespondent desires to know how to mount the tracheal system of insects so as to retain the air within the tubes. He finds that after a while the air is likely to be removed by the mounting medium. We would be glad to receive an article upon the subject from some one who has been more successful.

—A pound of cotton has been spun into a yarn over 715 miles in length. In the examination of textile fabrics it may be useful to know the relations between the sizes of yarns, as distinguished by their trade numbers. A cotton pound is 7,000 grains. When 840 yards of yarn weigh one cotton-pound, the yarn is designated as number 1. To get the number of

yards in a pound of yarn of any other number, multiply the given number by 840, thus: of No. 50 yarn there would be 50 × 840 = 4,200 yards in a pound.

—We have recently received a new Catalogue of Tolles microscopes, and telescopes, the 17th edition, in which we find several additions to the preceding one. There is an illustration of the large "C" stand, made for Dr. Blackham, in 1877, and cuts of the new mechanical stage recently introduced by Mr. Tolles. The usual list of testimonials is added, such as have been a feature of Mr. Tolles' Catalogues for many years. Application for catalogues should be made to Mr. C. Stodder, 131 Devonshire St., Boston.

—It affords us great pleasure to direct the special attention of our readers to the preparations of the Rev. A. B. Hervey, which have been advertised in this JOURNAL for several months. Only lately we have had an opportunity to examine a set of six slides, and we can commend them in the highest terms.

The preparations are intended to represent different modes of fructification characteristic of the red algæ, each one showing the ripened, sexual spores, which are produced by one of the families as distinguished by Agardh. The family of Gongylospermeæ, in which the spores are irregularly packed in a cystocarp, is represented by the common *Ceramium strictum*; the Cocceospermeæ, in which the cystocarp is compound, is represented by a section of *Callophyllis*, which shows the structure quite well; the bead-like strings of spores of the Hormospermeæ are beautifully shown on a specimen of *Hymenocladia*, and the cystocarp of *Nitophyllum latissimum* shows the terminal spores ripening in a manner characteristic of the family of Hormospermeæ. The Desmiospermeæ are represented by a fine specimen, showing the fruit of *Gelidium cartilaginum*, and the Corynospermeæ by *Polysiphonia variegata*.

All of these specimens are very instructive and, so far as we know, they are not to be found among the slides sold by the dealers. We hope Mr. Hervey will receive many orders, for the preparations are well worth the price asked for them.

—*The American Correspondence*, a weekly French-American diplomatic newspaper, published in this city, is keenly alive to the practical value of scientific research and discovery, as evidenced by several articles which we have lately noticed in its columns, one of which, relative to the microscopical examinations of Dr. Woodward in connection with the wound of the late President, is well worthy of mention. We are glad to notice that a newspaper, the columns of which are so crowded with diplomatic and financial matters, can occasionally find space for an article of a scientific nature.

— The artificial propagation of the sponge promises to become a profitable commercial enterprise. Professor Oscar Gratz has been so successful in his preliminary experiments that the Austrian Government has authorized the experiment on a large scale on the coast of Dalmatia. In the proper season, in spring, the living sponge is divided, and the pieces are attached to stakes, which are driven into the sea-bottom. In about three years the sponges grow to a useful size. It has been found that the cost of growing 4,000 sponges is only about $50.00.

—Prof. D. S. Kellicott, the Secretary of the American Society of Microscopists, has issued a circular, informing the members of the conditions for awarding the prize offered by Mr. E. H. Griffith, to "the author of the best paper on the adulteration of some important article of food or medicine," a ½-inch objective, by Messrs. Bausch & Lomb, at the Elmira meeting, next year. We will not publish them, for readers can obtain copies of the circular on application to the Secretary, at Buffalo.

—Messrs. J. W. Queen& Co. are now advertising some very useful novelties for the microscope, including a great variety of objects—double-stainings, injections, crystals, arranged diatoms, etc., etc., and some objectives and other apparatus by Zeiss. Among other things we notice a set of Ward's unmounted objects, prepared for mounting, with directions, forty varieties costing only $1.00. We would suppose that these would be very useful but we have not seen them.

MICROSCOPICAL SOCIETIES.

ELMIRA, N. Y.

The first regular meeting, since vacation, was held at the Surgical Institute, on October 27th, the President in the chair; 40 visitors were present. After reading of the minutes, and the election of several new members, Dr. S. O. Gleason read the

paper announced for the evening, entitled: "Blood, Leucocytes and Pus."

He stated that, notwithstanding blood-corpuscles had been examined under the microscope for the past 200 years, not until quite recently had their real structure been ascertained. The method for examining blood was thus explained: "Take a very small drop, mingle with it a 40 per cent. solution of bichromate of potash; and, to prevent evaporation, after it has been spread thinly upon the slide, surround it with a ring of oil, then apply the cover-glass." The average size of the red corpuscle was given as $\frac{1}{3370}$ of an inch. Their various forms—regular, irregular, rosette, scalloped, crenated, thorn-apple, and stellate shapes, were exhibited by diagrams, and the causes leading thereto, commented upon. "Aberrations, we said, have led to mistakes in supposing the corpuscle to be granular." The coalescence of corpuscles, giving rise to fantastic groups, was shown. The corpuscle at times, exhibits a central vacuole, or a number of them, which are round or roundish, with now and then some granular matter enclosed. The causes leading to the "paling" of the corpuscles, was explained, and the microscopic, internal appearence of them shown. The dotted net-work, with terminal threads, lost in the periphery of the corpuscle, was shown by diagrams and by specimens under the microscope. This net-work, it was explained, is indentical with that of the amœba, as described by Heitzmann. Changes constantly take place in the threads and dots, while they are under observation,—threads altering their lengths, dots changing positions. The double-contoured rings, called ghosts, were referred to. The ideas of different investigators as to the nature of this internal structure of the corpuscles, were given. The essayest inclined to Heitzmann's theory that the net-work is living matter, or bioplasm, and the granules, the contractile substance. This would make every corpuscle an independent, living body, capable of assuming many shapes.

Almost all investigators agree, said the doctor, "that the colored blood-corpuscles of birds, reptiles and fishes have a nucleus, while in man there is none, except in the developmental stage."

The white corpuscles were there described, and the part they play in leukemia and pyemia fully explained. It was shown that the red corpuscle is decolorized in the human body and there becomes a "leucocyte," "white corpuscle," "pus-corpuscle." He then gave Dr. Rollin Gregg's illustration of a boil, in which the stranded red corpuscles are changed into pus-corpuscles, by having the hæmatin washed out, while they escape from the vessels into the integument, losing their vitality and becoming pus-corpuscles.

The manner in which the red corpuscle is formed, in the mesenteric glands, and how a chyle-corpuscle becomes a well developed red blood-corpuscle, was explained. It was shown that the average life of a red blood-corpuscle is about six weeks; that 500,000 of them are made every minute; that as many die and are cast out of the body as are manufactured; that when this elimination is not perfect, disease follows,—pyemia, etc. When an unusual number of white corpuscles are found floating in the blood, it is because of the serum being too thin,—too great a number of red corpuscles are deprived of their hæmatin—the water penetrates the corpuscles, distends them into globules when they become dead bodies, which, if not cast off, become putrid, escape from the vessels into the tissues, and cause pyemia. Pyemia was next dwelt upon, and the manner in which painless abscesses are quickly formed, explained.

After the reading of the paper, the circulation of the blood in the mesenterium of a living frog was shown by Dr. Krackowizer; pus and blood globules by Dr, Gleason, and the circulation in the gills of a newt, by the Secretary.

The paper was then discussed by Prof. Ford, Prof. Clum, Dr. Krackowizer and the Secretary.

THAD. S. UP DE GRAFF,
Secretary.

WELLESLEY COLLEGE (MASS.)

The October meeting of the Society was held, the President, Miss S. F. Whiting in the chair. This was the first regular meeting of the College year. The time was chiefly occupied by Miss Whiting with a brief tribute to the memory of Mr. H. F. Durant, the founder of the College, who, though his name never appeared in connection with the Society, was largely instrumental in its organization and had ever been its most enthusiastic and generous supporter; sparing neither pains nor expense in his efforts to further the interests of the Society.

About thirty slides were exhibited by the

lantern and there were several rare and beautiful objects under the microscope.

LUCIA F. CLARKE, *Cor. Secretary.*

CENTRAL NEW YORK (SYRACUSE.)

A regular meeting of the Club was held on Tuesday evening September 27th at the office of Dr. Aberdein with a good attendance of members. Mr. E. H. Griffith, of Fairport, and Mr. Adelbert Cronise, of Rochester, were present as visitors. After the transaction of the usual routine business, Dr. A. Clifford Mercer read a paper, illustrated by black-board diagrams, on Prof. Abbe's theory of angular aperture. Dr. Mercer treated his subject ably and a demonstration of the somewhat obscure details of wave lengths and diffraction was very clear.

The Secretary then read a paper on Preservative Fluids, after which Dr. Chas. R. Lee exhibited some slides showing the appearance of a human lung when in a normal condition and when in a state of disease.

A. L. W.

ILLINOIS.

The first meeting of the State Microscopical Society for the present season was held at the rooms of the Society in the Academy of Sciences, Friday evening, October 14th, the President, Dr. Lester Curtis, in the chair.

After the transaction of routine business, Mr. Stuart described the microscopical structure of some vegetable drugs. The subject is not suitable for abstraction, and requires illustrations to be useful.

His paper was followed by one by Dr. Curtis, describing a new stand made for him by Bulloch. This stand presented some novel features, among the most striking was a mechanical stage of extreme thinness, admitting light at an angle of 160°. The movements were effected by a double pinion above the stage, an arrangement pronounced by those familiar with the operation of the contrivance, as exceedingly useful and convenient.

The stand aroused considerable interest as did also a right angled camera lucida of German manufacture which was adapted to it, the superiority of which over the ordinary form was so marked as to be unmistakable on trying it, even under the disadvantages of a crowded room and constant jar. After a discussion of the papers, the meeting adjourned.

E. B. STUART, *Secretary pro tem.*

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.

E. PINCKNEY, Dixon, Ill.

Wanted—First-class mounts of double-stain vegetable preparations in exchange for first-class insect preparations. H. S. WOODMAN,

P. O. Box 87, Brooklyn, E. D., N. Y.

Well-mounted Histological and Pathological slides in exchange for other first-class slides.

W. H. Bates, M.D., 184 Remsen St. Brooklyn, N. Y.

Wanted—first-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.

M. A. BOOTH, Longmeadow, Mass.

Wanted—Human Muscle with Trichina, in exchange for well-mounted slides of vegetable drugs.

OTTO A. WALL, M. D.,

1027 St. Ange Ave., St. Louis, Mo.

Niagara River Filterings for mounted slides.

H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.

C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Section of Brain, stained, showing Tubercular Meningites; also Carcinoma Cerebri. Please send list.

L. BREWER HALL, M. D., 27 South 16th Street.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus*, *Heliopelta*, *Pleurosigma*, *Isthmia*, *Triceratium*, *Surirella gemma* and *Terpsinoæ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.

DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides.*

LEWIS M. EASTMAN, M. D.,

349 Lexington Street, Baltimore, Md.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.

Rev. E. A. PERRY, Quincy, Mass.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.

HENRY FROEHLING,

59 N. Charles Street, Baltimore, Md.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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Fineness of Striation as a Specific Character of Diatoms.

BY PROF. H. L. SMITH, HON. F. R. M. S.

The October number of the *Journal of the Royal Microscopical Society* contains a translation of Count Castracane's paper, "On the Value to be Attributed, in the Determination of Species, to the Number of the Striæ of the Diatomaceæ," in which he arrives at the following conclusion: "The striæ and their fineness *are a quality of specific importance.*" In a few words appended to this translation, Mr. Kitton, the well-known English diatomist, criticises Count Castracane's conclusions, and indicates the mistakes of the Count himself in his attempt to make these measurements, which he deems of specific importance. The conclusion of the Count, however, will be heartily welcomed by "species mongers," inasmuch as one need have little fear in being able to sustain the claim to *n. sp.* if allowed to fall back on striation as the test, for, who shall decide? Not every one has at command the elaborate apparatus used by Count Castracane for determining the number of Striæ. Photographs of each diatom,—projections on an enlarged scale, etc.,—seem to be considered by him as the only trustworthy method; a method of such exactness that it "enables him to disagree with microscopists of incontestable authority." For Count Castracane personally, and as a correspondent and a thoroughly conscientious, hard-working diatom-student, I have the highest respect, but I am sorry that he has felt himself obliged to adopt so pernicious a view, as it seems to me. The diatomaceæ belong to the vegetable world and the principles governing their classification and arrangement, need not be very different from those accepted for other portions of the vegetable kingdom. It would seem that with as much propriety, one might consider the number of granules on a *Staurastrum* or striæ on the frond of a *Closterium*, of specific importance; or the number of fibres in a given space of a specimen of pine or oak, of value in determination of species. I venture the assertion, that if one were to show to the distinguished microscopist who has advocated this view of the importance of fineness of striation, a slide of diatoms, and request him to say what they were, he would name them all, correctly too, and never once resort to measurement of striation to do so. Now, if this can be done, and it is done every day by experienced microscopists, what is the necessity of bringing in an element which most students of the Diatomaceæ consider very variable and exceedingly difficult to determine? I would not have it understood, by what I have said, that I consider striation as of no importance; in conjunction with other things, it has a certain value, but at best only secondary.

I do not suppose that Count Castracane would, for a moment, assert that *Stauroneis Phœnicenteron*, e. g. has the same number of striæ in .001 of an inch as *Stauroneis gracilis*, and yet I have frequently found the latter conjugating and the sporangial frustule is *S. Phœnicenteron.* The spor-

angial frustules of the diatoms are notoriously more coarsely marked than the parent frustules. There are a great many species of diatoms, belonging to the *N. pinna* group, which really pass into each other so gradually, that even by the help of striation it is difficult to distinguish them; *N. affinis* produces, by conjugation, true *N. pinna*, and I have even observed the large frustules of the latter again producing monsters, by conjugation, far more coarsely marked than the parent frustules; shall we consider the sporangial form as one species, and the parent form another?

I have before me now, a slide of *Gomphonema olivaceum* containing myriads of frustules, many conjugating, and some with the parent frustules yet adhering to the sporangium. The comparative striation, as measured with a Powell & Leland spider-line micrometer, is very nearly as 4 to 6, and as the individual measurements of the parent frustules give for the striation 28 to 30 in .001-in., we have for the sporangial ones say about 20 in .001 in. In this gathering there are numerous free sporangial frustules, wholly formed, and quite as coarsely marked, and, apparently, numerous others of intermediate size and striation—of what value would striation be here? What I have said about *G. olivaceum*, is equally true of other diatoms, notably of the genus *Cymbella*. And yet, in connection with other characters the striation should not be ignored. In the same gathering, on *Isthmia enervis*, the striation may be so nearly the same on larger and smaller frustules as to appear to be of specific value, but it by no means follows that it will be the same in this species from a widely different locality, nor does my experience with Eulenstein's preparations of *Isthmia enervis*, coincide with that of Count Castracane. I find that the small granules on the connecting zone, or central portion, say in .001-inch, in the ratio of about 5 to 7, measuring, however, not with extreme accuracy, yet sufficiently accurately to show quite a latitude in this respect. Taking a pretty pure gathering, made at the time of the year somewhat remote from the time of the conjugation, I am quite prepared to admit that a preparation of the so-called *Frustulia Saxonica*, for example, will not show any appreciable difference in the striation of the frustules; but I would be quite unwilling to admit that this diatom could not be obtained from another locality, considerably more finely or more coarsely marked; indeed, Count Castracane himself admits a difference, though he says it has never, to his knowledge, exceeded $\frac{1}{8}$, which, as Mr. Kitton shows, gives a range in *N. crassinervis*, if he understands aright, of 27 to 35 in .001 an inch!

The general character of the striation, parallel, radiate, etc., the character of the median line, if present, the comparative fineness or coarseness of the striæ,—all these are, no doubt, important, as is also within limited range, the number of striæ in .001 of an inch. Anyone looking over Mr. Habirshaw's "Catalogue of the Diatomaceæ" will realize what a frightful increase of species was made by Ehrenberg, and the earlier observers, from considering the number of rays, in the genus Actinocyclus as of specific value, equally pernicious is the custom too largely indulged in at the present day by many hard-working Continental observers, who, looking from the stand-point which Count Castracane appears to advocate, find at stated intervals new species, founded upon little else than finer or coarser striation, or perhaps somewhat different outline. It is, no doubt, quite a comfortable way of working, and of keeping one's name before the public when one finds what is supposed to be a new diatom, if, only knowing enough to distinguish the genus, one measures, more or less correctly, the length, breadth, or diameter, and the number of striæ in .001 of an inch, giving sometimes a repre-

sentation, which, if it be one of the smaller Naviculæ may too often equally well represent many other forms, and, finally, to coin some unpronounceable word, or immortalize some friend, and sends forth the bantling; since nobody can venture to question its legitimacy, for does it not differ somewhat from every form hitherto figured or described in outline? And has it not a few more or less striæ in .001 of an inch. I shall be very sorry if, in what I have said, I am considered as censuring men who are unquestionably hard-working and conscientious students of these interesting little organisms, I am only regretting that, instead of laboring to reduce the genera and species of the Diatomaceæ, and seeking for broader and firmer principles to guide in their study and classification, so many worthy persons are contented to accept trivial distinctions as of generic and specific value, and they are so encumbering the subject, that some day it will be crushed by its own dead weight, giving place to a new structure, utilizing as far as possible the ruins, but erected upon a more solid foundation.

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Is it Tintinnus?

BY C. M. VORCE, F. R. M. S.

In Dr. Leidy's work on Rhizopods, on plate XII, figs. 19, 20, 21, and on plate XVI, fig. 35, are figured what is there called *Difflugia cratera;* under this name it is described on page 108. Appended to the description, and to the list of the figures on plate XII, is a foot-note in substance as follows: "Since writing the above it has occurred to me that these forms may be the shell of a ciliated infusorian of the genus *Tintinnus.*" It appears also, from the description of the species and of the plates, that all of the specimens figured by Prof. Leidy were dead shells, two of which were from the water-supply of Buffalo, N. Y. This shell has for years been common in summer in the water-supply of Cleveland, Ohio, but until quite recently I have not seen it alive or heard of its being so observed. It has always been called here a *Difflugia.*

This summer Dr. Robert Dayton, of this city, in speaking of the forms in our water-supply, mentioned this as a free swimming form, at which I was somewhat surprised at first, having so often noticed it and never having seen it move, but soon afterward he exhibited to me an individual of this species which was not only alive but active. This specimen was somewhat shorter and more robust than Leidy's fig. 35 on plate XVI, and with the apex slightly more pointed, but it is undoubtedly the same species. It was attached by the edge of the lips of the shell to a mass of green, vegetable debris, and alternated periods of quietude with periods of vigorous threshing up and down, as if trying to break loose from its attachment, which, however, must have been voluntary, as the edge of the shell was in but the very slightest contact with the mass to which it adhered.

While it rested, the mouth of the shell was uppermost, and the observer looked directly down into the interior of the shell. In this position there was visible a strong vortex current in the water over the mouth of the shell, but not within it, so far as the visible particles in the water would indicate, for these were plainly seen, both in a top view and afterwards in side view, to pass directly across the mouth of the shell, barely passing below the level of the edges. The vortex produced by this species is very peculiar, and quite different in character from that produced by a Rotifer or a Vorticella: the movement of the particles in the water is slower and steadier, and the acceleration of speed as they approach the shell is less noticeable; they pass steadily across the mouth of the shell, all moving in one direction, and sail quietly away on the other side, not often returning in a circle to pass through the vortex again and again, as

is the case with *Vorticella*, etc. Nevertheless, some part of the current produced by the vortex must pass into the shell, or at least into the neck, and invisible particles in the water are appropriated by the creature for its nourishment.

When the shell was disposed vertically to the observer, the wide, belt-shaped mouth and upper part of the neck are clearly seen, and no cilia nor even sarcode could be made out in those parts ; the body of the shell contained a yellowish mass, of clear, jelly-like appearance, transparent, but so deep that its yellow color rendered the outlines of the sand-grains composing the fundus of the shell indistinct, although they were visible through it. No movement of this jelly-like mass could be seen, even with a Hartnack $\frac{1}{8}$ objective and high oculars, although the vortex in the water was observed at the same time.

When the jerking movement commenced the vortex stopped, and as the shell ceased its violent swaying and began to sink by its own weight to a vertical position, the vortex recommenced. The periods of quiet were from three to ten times the duration of the periods of jerking up and down.

Later on I obtained a gathering from the water-supply in which I observed this same form swimming freely. It moved in a slightly oblique position with the mouth uppermost and advanced, rotating slowly at times, and again sailing smoothly along without turning on its axis. It frequently bumped roughly against diatoms and other masses of entangled matter in the water, in which case it usually paused but for an instant and sailed away again, but occasionally it remained in contact with such masses of matter for some moments, during which time the characteristic vortex was seen in full play. This specimen was not seen to go through the performance of attaching itself and jerking about, but when starting from a state of rest into motion it started with a movement very much like a jump, often turning a quarter round with the first impetus and swimming quickly off. No cilia could be discovered in this specimen with any objective up to a one-eighth.

There is no work accessible to me by which I can determine the genus and species of this organism, and I submit my observations in the hope that someone who has the means may determine it, and inform us through the columns of the JOURNAL. It is a high tribute to the genius of Prof. Leidy that he was not misled, even when examining dead shells, by the remarkably exact resemblance of this form to undoubted Rhizopods, into pronouncing it to be certainly one of that class.

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Useful Apparatus.

Whoever has found occasion to mount objects, such as foraminifera, which must be selected from a mass of sand and other debris, cannot fail

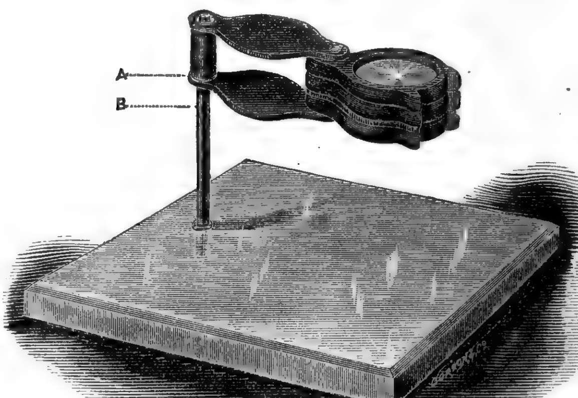

FIG. 49.

to appreciate the usefulness of such

an instrument as is represented in Fig. 49. It is made by the Bausch & Lomb Optical Company, and is known as the "Handy Dissecting Microscope." The base is a thick plate of glass, into which the steel stem supporting the lens is screwed. By placing a sheet of white paper beneath the glass, a good illumination from below can be obtained, and by the use of a bull's-eye condenser, opaque objects can be easily selected for mounting. We commend this instrument thus unreservedly, without having used it, because it is practically just the same as an arrangement which we contrived long ago, and which we found to be very useful for many purposes. For dissection a more elaborate microscope is made by the same Company at a reasonable cost, but we still think that good dissection-microscopes are entirely too costly. The "Complete Dissecting and Mounting Microscope," to which we allude, is represented in Fig. 50.

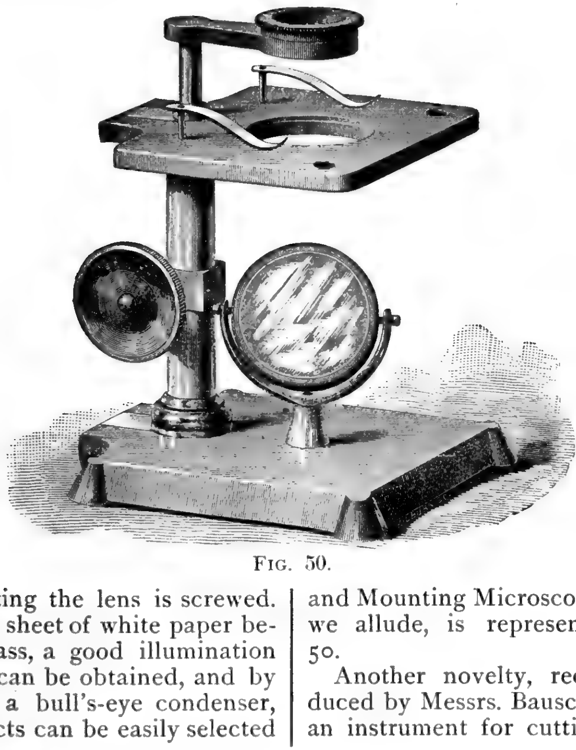

FIG. 50.

Another novelty, recently introduced by Messrs. Bausch & Lomb, is an instrument for cutting circles of thin glass, shown in Fig. 51. It is attached to the turn-table, by means of the screw shown at the right of the figure, so that the cutting point stands over the turning plate. The thin glass is placed upon the turn-table

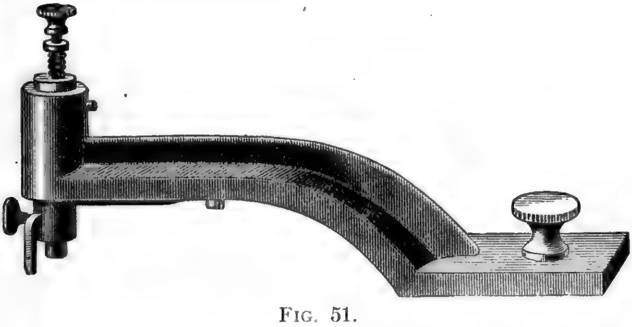

FIG. 51.

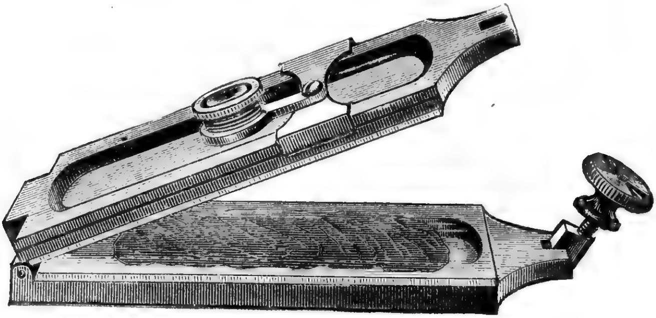

FIG. 52.

and held by the central pin which then revolves with the glass. A gentle pressure causes the cutting point to touch the glass, and perfect circles can thus be readily obtained.

The "Trichinoscope" is an instrument devised for the ready examination of meat for the detection of trichinæ. It consists of two plates of glass, between which the fragments of muscle are placed and pressed out thin, by means of a screw. It is shown open and closed in Figs. 52 and 53. Above the upper plate there is a lens

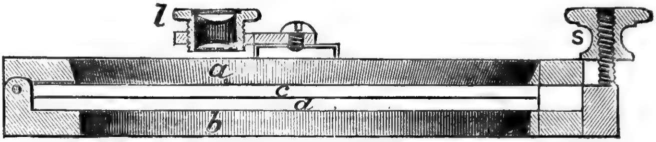

FIG. 53.

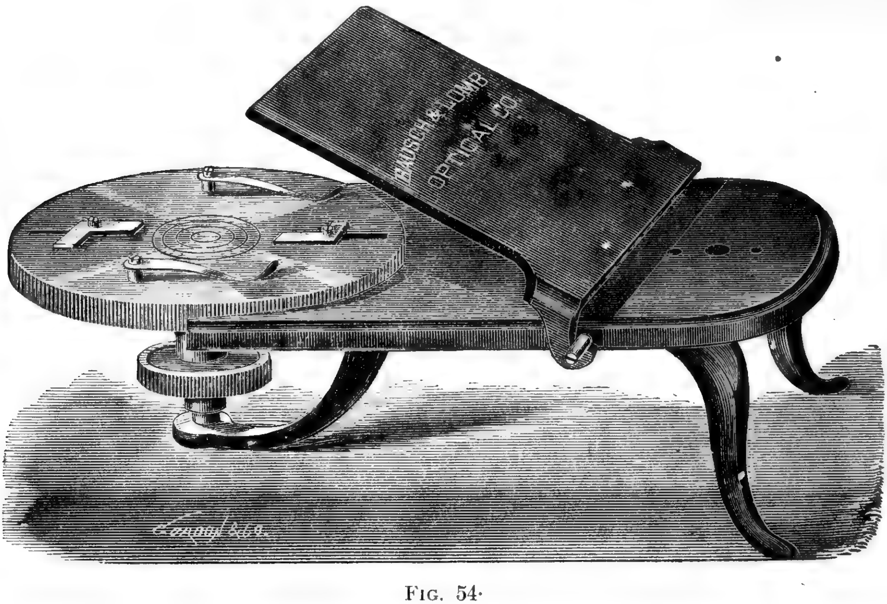

FIG. 54.

of sufficient power to distinctly show the worms. The lens can be readily focussed by the screw-fitting.

The new turn-table, represented in Fig. 54, is an ingenious affair, and runs very smoothly. It is provided with a hand-rest, shown in the cut, which can be readily adjusted to any convenient height.

Motion of Diatoms.

I am able to confirm, from actual observation, the correctness of the views of Dr. Wallich, as quoted by your correspondent "J. D. C." (MICROSCOPICAL JOURNAL, Nov., 1881, p. 206), relating to the Motions of the Diatomaceæ.

Mr. Wallich ascribes these motions to "the existence of prehensile filaments, capable of alternate extension and retraction, of extreme tenuity, yet of extraordinary strength and elasticity."

I have not been able to see these filaments in living diatoms, and therefore I cannot verify the assertion as to their "alternate extension and retraction," but as these filaments are undoubtedly composed of protoplasm and may be fairly compared with the pseudopodia of the Rhizopods, there is no reason to doubt that they possess this power.

I have seen them frequently, in certain diatoms found in abundance in the gutters of New Orleans. (A photomicrograph of one of these is enclosed herewith.)

My observations were made during the summer of 1880, while especially engaged in studying the bacteria found in the same situation in great variety, and the demonstration was made with the 1/8-inch homogeneous oil-immersion objective of Zeiss, and by the use of iodine solution as a staining fluid. The vitality of infusoria and of diatoms is instantly arrested by a 2–5 p. c. solution of iodine, dissolved by means of potassium iodide, and the slender filaments referred to are brought into view by the staining of the protoplasm, and by a prompt coagulation which prevents them from being withdrawn, as would very likely occur if their vitality was not instantly arrested. The cilia of ciliated infusoria, such as Paramecium, etc., are beautifully shown by this method, with comparatively low powers. They project from the body like rigid rays and may be photographed. I have not yet made the attempt to show the filaments referred to, depending from the lower valve of a diatom suddenly killed by iodine solution, but believe that this would be quite practicable, although a more difficult matter than the photographing of the cilia of infusoria, and perhaps as difficult as the demonstration of the flagella of *B. termo*, which, I confess, I have not succeeded in making.

G. M. STERNBERG,
Surg. U. S. A.

FORT POINT, San José, San Francisco, Cal., Dec. 2d, 1881.

New Method of Mounting Butterfly-scales.*

Dissolve one part of Anthony's "French diamond varnish" in two parts of pure benzole. Apply a drop or two of the solution to a slide, and in a few seconds, or as soon as the varnish has set, press the wing of the butterfly gently upon the slide, and then carefully lift it away. The scales will be found transferred to the slide in their beautiful natural arrangement on the wing. Make a shallow cell around the mounting and apply the cover-glass. Canada balsam must not be used, as it disarranges the object.

The Preparation and Mounting of Salicin Crystals.*

The following apparatus is recommended :—

1st. A kerosene lamp, or an argand gas-burner, with a long chimney.

* Read before the New York Microscopical Society, by Mr. B. Braman.

2d. A block of iron six inches long, four inches wide, two inches thick, with a smooth surface for cooling slides.

3d. A three-inch glass funnel.

4th. A small beaker.

5th. A filter. For a filter, put a wad of clean cotton wool into the funnel, then wet the cotton with alcohol, then wash out all the alcohol with pure water.

The work embraces the following steps :—

1st. Clean the slide perfectly with ammonia, then rinse with hot water, then cleanse with ammonia again.

2d. Add to the salicin from one-tenth to one-twentieth its weight of pulverized gum arabic.

3d. Make a nearly saturated solution of the salicin and gum in distilled water, or in ice-water heated to the boiling point, and carefully filter the solution.

4th. Heat this solution to 100° C. in the beaker.

5th. Pour this hot solution upon a still hotter slide, and drain off.

Only a hot solution will give bright colors.

6th. Hold the slide, and watch for discs of crystals. As soon as these appear, place the slide on the cold iron block.

7th. A rim is put on the crystals by another heating over the lamp, and another cooling on the iron.

8th. Without delay heat a drop of Canada balsam on a circular cover-glass, and apply the cover to the crystals.

9th. Fasten with white zinc cement by using a turn-table.

The process described, if followed with care, will yield most excellent results ; perfect rosettes of crystals can be readily obtained, giving brilliant effects with polarized light.

For this process, as well as for the method of mounting butterfly-scales already described, I am indebted to Dr. Daniel H. Briggs, of Philadelphia.

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Parasites of White Ants.*

BY DR. AMOS SEIP.

In taking even a superficial view of the animal and vegetable kingdoms, we are brought at once to recognize the fact, that parasitic life, in almost infinite variety, is to be found distributed in the most wonderful manner. Plants, as well as man and animals, have their peculiar parasites and parasitic diseases. History furnishes numerous examples of periods of blight in the vegetable kingdom, associated with epizootics among the lower animals, and with epidemics affecting the human family ; in the study of which, our favorite instrument, the microscope, comes in for its due share in their examination and investigation. Kuchenmeister and Leidy have shown that each parasite has an independent life ; that most animals have their own peculiar parasites ; that even parasitic animals and plants are infested with parasites ; thus proving the truth of the couplet, here slightly altered from its original form :—

" Big fleas have little fleas
" To torment and bite them,
" And little fleas have lesser fleas,
" And so *ad infinitum*."

I would not propose, even if time permitted, to enter upon a discussion or description of parasitic animals in general, for the field is well nigh inexhaustible ; but having found an opportunity to collect a few specimens of the white ant a few days since, I enjoyed the rare sight of examining the wonderful parasites with which they are infested.

To our distinguished countryman, Dr. Leidy, belongs the honor of this discovery, and to his work, giving their history and description, I am indebted for whatever I may say concerning them. The white ant, *Termes flavipes*, is to be found in the dry, sandy forests and fields of southern New Jersey. Those here exhibited were found in the vicinity of Budd's

* Read before the New York Microscopical Society, November 18th, 1881.

Lake, about thirty miles from Easton. They were obtained from an old oak trunk and from the bark of an old pine stump, in the latter of which they are most frequently found. I searched in vain for them, last year, in the woods in the vicinity of Easton, although it is possible they may yet be found there. In 1877 Dr. Leidy first observed these parasites, and a brief notice of them was published. Three or four varieties of these remarkable protozoans are enumerated by him, but he adds: "There may be some forms that are merely younger stages of the same species."

The most conspicuous and extraordinary of the parasites has been named *Trichonympha agilis;* and, notwithstanding all his study, Dr. Leidy declares his inability to determine its character sufficiently to decide whether it should be regarded as a ciliated infusorian, a gregarine, or a rhabdocœlus turbellarian; but he is disposed to regard it as the former, or rather as of intermediate character between the first two. There appears to be something like food in the centre of many of them, but Dr. Leidy says he has watched for hours myriads of individuals, without ever seeing one of them swallow or discharge a particle of food. My own limited experience corresponds with this statement. Thus far no contracting vesicle has been observed. I do not pretend to give an elaborate description of the head, body, cilia, etc., time will not permit. Among the more beautiful varieties, he classes also the *Pyrsonympha*, which may be distinguished by its zigzag, undulating movement, and the wavy movement of its cils. A large nucleus is present in *Pyrsonympha*, it is oval or round, and often appears ovoid or pyriform, This animal is classed as a ciliated infusorian.

Another of the parasitic community is known by the title of *Dinenympha*, or whirling nymph, a ciliated infusorian, probably related to the familiar genus Opalina, though, unlike this and like its associates, it appears to swallow food; its body contains variable proportions of coarse granules. *Dinenympha* is an active creature, incessantly in motion, though, like its associates, remains nearly stationary in some positions, it always appears twisted and of somewhat spiral form. It is closely invested with short, rapidly vibrating cils.

Time will not allow me to describe this numerous but beautiful family; I barely enumerate a few more by name.

Iracis Migrans. This animal corresponds to one of the same name inhabiting the proboscis of the house-fly. A gregarine has also been noticed in the Termite. Vibrios occur also in great numbers. *Æthromitus* was the name originally given to a genus of delicate filamentous plants found in the intestines of certain myriapods, *Spirobolus Marginatus*, and of the coleopterous insect, *Passalus cornutus.* Careful examination proves this plant to be the same, and as if to fill up the measure of life capable of being sustained by the termite, it is infested with a mite—a species of *Gamasus.*

Termites, as Leidy well observes, are so common and easily obtained in many neighborhoods, they will, no doubt, become favorite subjects to illustrate the infinity of life and the wonders of the microscope.

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A New Cement.

BY PROF. C. B. PARKER, M. D.

I desire, through your excellent columns, to call the attention of your readers to a preparation for permanently sealing and finishing glycerin-mounts, presented, I believe, for the first time to American microscopists. All admit the desirability of glycerin-mounts, and, indeed, the impracticability of preserving certain objects in any other way; yet, if my experience corresponds with that of others, I have often had to mourn the destruc-

tion of some favorite specimen from the running in of the cementing substance, or the running out of the glycerin.

It was in the winter of 1878–79 that my attention was first called to a substance known in the Pathological Laboratory, at Vienna, as *Venedischer Damarlack* (Venetian damar varnish), which was exclusively used for sealing and finishing glycerin-mounts. On my return home I found that no such substance was known to the trade. After experimenting with various articles I have found that Venice turpentine, prepared as presently to be described, if not identical with, it at least answers every purpose equally as well as that known in Vienna under the name of Venetian damar varnish. Mr. Hopp, of this city, who has conducted the experiments, kindly furnishes the following directions for preparing the turpentine.

Dissolve true Venice turpentine in enough alcohol, so that after solution it will pass readily through a filter, and, after filtering, place in an evaporating dish, and by means of a sand-bath evaporate down to about three quarters of the quantity originally used. The best way to tell when the evaporation has gone far enough, is to drop some of the melted turpentine, after it is evaporated down to about three quarters its original volume, into cold water, and in being taken out of the water if it is hard, and breaks with a vitreous fracture on being struck with the point of a knife, cease evaporation and allow to cool.*

The following hints for applying the turpentine may be found useful. Square covers should be used. The cover-glass being adjusted with the usual precautions observed in glycerin mounting, the surplus glycerin, if any, should be wiped away, and the slide so placed that the edges of the cover-glass are plainly seen.

A piece of wire No. 10–12 (copper is the best, as it gives to the turpentine a beautiful greenish tinge) is bent at right angles, the short arm being just the length of the cover-glass used.

The wire is heated in the flame of an alcohol lamp, and plunged into the prepared turpentine, some of which adheres to the wire. The wire is then brought down flat upon the slide at the margin of the cover, and the turpentine will distribute itself evenly along the entire side of the cover. The same process is to be carried out on each of the other three sides. Any little unevenness may be removed by passing over it with the heated wire. The advantages of this substance, over all others used for a similar purpose, are:—

It is secure. I have such thick objects as the female organs of *Vermicularis* and *Tricocephalus dispar* in glycerin, finished in this manner, which are as tight and firm as when first mounted in 1878.

It hardens immediately. The moment the heated wire is removed the specimen may be cleaned and handled without fear. This is, perhaps, its chief advantage over such slow drying fluids as damar and balsam. It never runs in, as white zinc and other cements are so apt to do.

CLEVELAND, O.

* The prepared turpentine is kept on hand by Mr. A. Maxwell, pharmacist, Cleveland, O., who will fill all orders.

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Our Histological and Pathological Laboratories.

BY J. W. CRUMBAUGH, M. D.

Previous to furnishing and opening my microscopical laboratory, I visited those connected, directly or indirectly, with the medical colleges in this and other cities. My greatest surprise was at their primitive methods. The only one I visited that afforded quick, and mathematically correct, means of work, and that was not open to students, was the one under the direction of Dr. J. J. Woodward, in the Army Medical Museum, Washington, D. C. The very limited time allowed for instruction in this

department of science is an excuse given for all their shortcomings; but it is partly owing to this very lack of time that I should insist upon the introduction of improved apparatus. The instruction in the theoretical part of the course is, with few exceptions, good, and as thorough as the time will permit. One almost universal failing, however, is a lack of enthusiasm on the part of the instructors—a failure on their part to impress upon the student the great practical importance of the study of the healthy and diseased human structures, microscopically. This is evidenced by want of interest among some of the students, who claim to learn only what is practical. Let us hastily review a course as given at one of our best and most thorough institutions.

A few hurried remarks about the microscope, generally introduces the course. Any one, however, who is to use a microscope, for any purpose, should be able to choose one for himself, with perfect working parts and furnished with enough of the modern appliances to render it adaptable to his purposes. To depend entirely upon the word of the optician is apt to prove unsatisfactory, in these days, when every spectacle peddlar is dubbed optician. Hence, the propriety of sound common-sense instruction, as to what a microscope should be. The advantages of the fine adjustment moving the entire body, and the disadvantages of its being on the nose, the thin stage, swinging-bar and sub-stage, special forms of diaphragms, sub-stage condensers, their uses and advantages, should all be dwelt upon, as well as a host of other things never mentioned, and in respect to which a student remains ignorant until he has had a tenth-rate foreign instrument thrust upon him at "sixty per cent. off list." Even then he is ignorant of what he has missed in not having purchased a good American stand.

Our instructor having finished his description of the microscope, then shows us a stage-micrometer and its uses, and how to determine the magnifying power of the different combinations. I would suggest that the concurrent use of the eye-piece micrometer would be of value, and this has been introduced into one of the laboratories. Next, we are taught the use of the camera lucida; but invariably the cameras used are so constructed as to necessitate the horizontal position of the microscope when in use. This is a grand mistake. Many times one feels the necessity of a camera lucida, when to change the position of the stand is to lose the object under observation. There are more modern affairs than these, and why not give the student the advantage of using them? The Messrs. Beck make a camera that can be used out of the horizontal, but, of course, the best of them all is by Zeiss. The expense may be an objection, but not an insuperable one in most cases. The laboratories should provide the students with the best, and most approved, apparatus, for it is by the use of labor-saving apparatus that the busy practitioner is enabled to carry on his pathological investigations.

Having mastered these subjects, and learned how to polish up the barrel of our microscope, we are considered fit to begin the study of histology. Before following this step, I will make a suggestion: Would it not be well for us to know more about the manipulation of lenses. It is true we have become acquainted with our dry $\frac{1}{4}$ or $\frac{1}{5}$, and that almost everything we will investigate is demonstrable by means of these powers. But there are some structures that are not satisfactorily shown, and for these we want greater resolving power and higher magnification; and as these higher powers are usually made immersion with collar-adjustment, the manipulation of this kind of objectives should be practiced. The homogeneous-immersion systems

should also be used, and their advantages and disadvantages demonstrated.

I take it for granted we have learned something of illumination, and the use of achromatic and monochromatic light. So, without further parley, we take up the blood as the first subject for investigation: first, frog's blood, then human. We study its anatomy in the passive state, and are left to imagine what relation the different corpuscles hold to each other while circulating. The circulation, as seen in the bat's wing, frog's foot, or the gills of the salamander, is something which every medical man should not only look at but study; and, having thoroughly studied it in its normal state, he should follow it through the different stages of inflammation. Blood-crystals come next in our course. The dry blood process is used generally, and we obtain some fair crystals. The wet processes are usually ignored, and foolishly, too, for by their means we obtain the most perfect specimens. The medico-legal branch of the subject is rarely touched upon. Then, without teaching the mode of permanently preserving the blood-corpuscles and crystals in wet or dry mounts, we are led on to connective tissues and the epitheliums. A little staining in carmine is now done, and we begin to feel we are doing something. We tease out muscular and other tissues, and really begin to cut sections—that is, to chip off wedges. The hardening of the tissues does not concern us particularly—it is enough for us to know they were once soft, now hard, and since hard we have the privilege of purchasing a fine set of dissecting instruments, and a Valentine or other knife for section cutting. Why are not laboratories furnished with all the tools necessary to accomplish the desired purpose? Teach the students what good tools are, so they can choose such when they purchase. Such a thing as a microtome is seldom thought of, still less frequently seen. A very ingeniously cut and folded piece of writing paper, converted into a box, receives the specimen and embedding material, and serves as the microtome. The micrometer screw is your eye, plus a delicately trained hand and arm. As a result, the majority of men go out from our colleges incapable of cutting a transparent, even section, and never dreaming of such a thing as a microtome. We must not neglect the freezing microtome, even if to see it in the demonstrator's hands is the nearest we can approach it, we will have that much to be thankful for. After running hastily through the urinary deposits our course ends.

Turn-tables and the host of finishing cements are foreign to the "practical" laboratories. Balsam and damar are the mounting media and finishing cements. Turn-tables for centering objects are a superfluity, simply because an object mounted out of centre is in all respects equal to an object mounted in centre. And suppose the edges of the cover have not been cleaned of the balsam —suppose they do look smeared. That does not affect the value of the preparation beneath the cover. Such is the laboratory talk; and it may be true to a certain extent. But the converse is equally true—the decentered object and smear do not enhance its value, while a neat finish to a centrally mounted object is, to say the least, pleasing to the eye.

The exchanging of slides has become so common a practice among microscopists that almost every worker has specimens of almost every other one's work. Run over the cabinet of one who has done much exchanging, and what do we find? One thing particularly, viz.: that almost all the badly cut and mounted specimens have physician's names on their labels. Few glorious exceptions there are, but upon inquiry we find that none of these received their knowledge from their *alma mater*.

The dissecting microscope is an-

another piece of apparatus too frequently absent from our laboratories. This is inexcusable, when most admirable instruments for this purpose are now sold by several makers.

Zeiss' binocular eye-piece and homogeneous-immersion lenses should also be represented. One thing more. The literature, either special or general, in book form or in journals, is seldom found in our laboratories. Every new work on the subject worth the buying should find its way to the students through their instructors. All of the best journals on the subject should be at their command.

In the foregoing hasty sketch, I have endeavored fairly to represent some of the defects of our present system, especially as to the furnishing of our laboratories, and in the instituting of my work-room I have, as far as time has allowed, attempted to correct their defects; my object being to have a laboratory furnished with the latest and the best of everything, thus enabling anyone so inclined to pursue a line of investigation, which limited, private resources might forbid.

PHILADELPHIA, November, 1881.

EDITORIAL.

Subscriptions.—Remittances for subscription should be made by post-office money-order, by drafts payable in New York, or in registered letters. Money sent in any other way will be at the sender's risk. A receipt will be immediately given for money received by open mail.

—We sincerely regret the delay in the publication of this number of the JOURNAL, but it has been caused by an unusual pressure of work in the printing office. Only on two or three occasions in the history of this paper has the publication been noticeably delayed beyond the regular date, the 15th of the month, and never, so far as we remember, has it been for more than three or four days.

In sending out this, the last number in the year, we extend to our subscribers, with so many of whom we have come to feel a sort of acquaintance through correspondence, and with whose handwriting we are as familiar as with that of intimate friends, a cordial Christmas greeting. To each and all we wish a prosperous and a Happy New-Year.

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MICROSCOPICAL SOCIETIES.—In our next issue we will have a few words to say concerning the publication of reports from microscopical societies, since we have decided to make a change next year in this regard. In order that we may fairly indicate, in the January number, the course to be followed hereafter, we would request the secretaries of those societies, who desire to have their proceedings noticed, to send us their reports promptly.

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MOTION OF DIATOMS.—The communication from Dr. Sternberg on page 227, relative to this subject, is deserving of the attention of students of the diatoms. Dr. Sternberg is a careful observer, and his observations are not to be lightly set aside. We trust he, or some other competent person, will take early occasion to test the correctness of his conclusions. The photograph enclosed with his article represented a diatom of the genus *Navicula*.

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TO OUR READERS.—In preparing the Index to the second volume of the JOURNAL, which accompanies this number, we have felt pleasure in observing the large number of articles printed in the course of the year, which are valuable for future reference. We may be pardoned for expressing a certain degree of satisfaction at the present condition and prospects of the JOURNAL, since such a feeling is due not alone to the results of our personal efforts, but more particularly to the cordial support and coöperation of some of the most widely-known and most able microscopists in the country. In the beginning we stated our desire and intention to establish an American journal, and to

fill it with contributions from American authors. A few persons had grave doubts whether there were a sufficient number of microscopists in this country who would contribute to such a paper and make it successful. As a matter of fact, however, we have not yet been obliged to reprint a single article from another publication.

The JOURNAL is nothing more nor less than it purports to be—a magazine devoted to practical microscopy. It aims to keep its readers informed concerning the progress of microscopical research, especially in the United States; but a glance through the Index will show that investigations in other countries have not been overlooked in the "Notes" and editorial articles. That its elementary character does not make it unworthy the attention of scientific men and investigators engaged in original work, the subscription-list clearly shows. We would, indeed, be pleased to give the JOURNAL a more advanced position in the periodical scientific literature of the day; but to do so would involve greater expense for illustrations, with an increase in size, and it is doubtful if such a change would be advisable.

We are pleased to add that the critical period of the existence of this periodical is passed, and that its success is assured. The prospects were never better than they now are. During the year just closing the subscription-list has been slowly but steadily growing, and we have reason to expect many additions next year. Subscribers will please remember that the early payment of subscriptions greatly assists the business management of the JOURNAL.

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PROF. ABBE'S BINOCULAR EYE-PIECE.—A letter from Mr. Zeiss to the Secretary of the New York Microscopical Society, gives some information about this instrument. It is sold for 150 marks at Jena—Mr. Emmerich offers it for $56.25 in New York. It is adapted to the continental microscopes with short tubes, and though the same system could be applied to long tubes, the prisms would have to be quite large, and the apparatus would be too large and heavy for convenience. The oculars as now made permit correct adjustment of the diaphragms for any length of tube between 13 $^{cm.}$ and 16 $^{cm.}$ (5.2 and 6.4 inches). It weighs about 600 grammes.

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MICROSCOPE EXCHANGE-BUREAU.—Many of our readers have second-hand stands or objectives which they desire to sell, and we are frequently asked to find purchasers for them. We also have frequent applications from others who wish to buy either new or second-hand apparatus. We have, therefore, decided to establish an "Exchange-bureau" for the accommodation of those who desire to sell or buy second-hand microscopes or accessories. We merely call attention to the subject in this place, referring to the advertisement on page v for further particulars.

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DEATH OF M. C. S. NACHET.—The London *Times* of Nov. 22d contains a notice of the death of M. Camille Sébastien Nachet, written by Mr. John Mayall, Jr., which we print in full:—

"At the last meeting of the Royal Microscopical Society the death was announced of Mr. Camille Sébastien Nachet, the founder of the well-known firm of opticians Nachet et Fils, of Paris. Early in life M. Nachet formed a friendship with Chevalier, the eminent optician, of Paris: he took great interest in the construction of optical instruments, particularly microscopes, on which Chevalier was specially engaged. At that date the improved manufacture of various kinds of flint glass by Guinaud (the predecessor of Pfeil), of Paris, gave a great impetus to the improvement of microscopes on the Continent, while engaging the attention of Brewster, Herschel, Goring, Dollond, Pritchard, etc., in England. En 1834 M. Nachet undertook the direction of the microscope department in Chevalier's house, and during

six years his skill and ingenuity largely contributed to the reputation of the house. In 1840 he commenced business on his own account, devoting himself particularly to the microscope and the specialties required in ophthalmic surgery. In 1842 he contributed a paper to the Académie des Sciences (Tome xiv), describing the construction of achromatic lenses, in which curves of half a millimetre in radius were utilized. From that date he received encouragement from some of the leading scientific men of Europe, such as Amici, Arago, Milne-Edwards, and later on of Drs. Lebert, Robin, etc., for whom he executed numberless experimental devices. In 1843 he exhibited at the Académie des Sciences his camera lucida, which is still regarded as one of the best forms of that instrument. In 1844-5-6, his name appears in the *Comptes-Rendus* with numerous improvements of the microscope. In 1847 he brought out his prism for oblique illumination, using the mirror in the axis —the forerunner of a large number of devices in which the total internal reflection of glass surfaces has been utilized. His son then joined him in partnership, and the firm brought out in rapid succession binocular microscopes, dissecting microscopes, etc., which occupy a prominent place in the popular text-books. M. Nachet's liberality in carrying out the construction of experimental apparatus rendered his house a favorite resort of amateurs of the microscope. For some years past he had ceased to take part in the business. His death took place in Paris on the 28th ult., in his 83d year."

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PROF. JOHN BACON.—We have also to record the death of Prof. John Bacon, at his home, in Boston, on Monday, Nov. 28th. Prof. Bacon was one of the earliest American microscopists. For nearly forty years he has seen the progress of microscopical study and the improvements in the instrument, securing for himself whatever seemed to be of value among the latter. About the year 1847 he visited Andrew Ross, in London, who then informed him that 147° was the utmost limit of angular aperture that could be given to an objective.

For fourteen years he was Professor of chemistry in Harvard College, but in 1871 he resigned on account of ill health; since then he has given special attention to the study of diatoms. His cabinet of diatom-preparations is very valuable, and his library contains perhaps the most complete collection of works on the diatoms in the country. He was a man of ability and an excellent chemist, but of a retiring disposition, and therefore almost unknown to the general public.

——o——

EYE-PIECES.—A committe of the American Society of Microsopists, appointed at the Detroit meeting, but continued this year with the addition of Dr. Blackham, has issued a circular especially addressed to manufacturers of microscopes, the object of which is to secure uniformity in the nomenclature and in the size of oculars. If the Society can accomplish this very desirable end it need ask for no greater fame. Is the task a hopeless one? We would like to know what replies have been received up to this time—how many manufacturers heartily sympathize with the movement, commend it in highest terms, but, for various reasons, answer "No" to the fourth question, which reads: "Will you adopt such a nomenclature if decided upon by this Society;" or to the tenth question, "Will you adopt a standard set of sizes, if agreed upon and recommended by this Society?" We would like to believe that all American and English manufacturers would feel themselves bound by the interests of their customers, to adopt such a set of standards—and in our opinion not more than two sizes of tube should be adopted, a small tube and a large tube. But we can see why large manufacturers may object to changing their sizes, because of the expense involved, and we believe that the only way to secure this uniformity is to present its advantages so clearly before the purchasers of microscopes that they will demand it. Nevertheless, we believe the efforts of the committee will be productive of some good. If proper judgment is exercised in selecting the standard,

if there is no reasonable objection to the nomenclature recommended by the committee, we have no doubt but success will eventually follow. We do not look for immediate results from this movement, although we are sure that some of our American manufacturers will be glad to act upon any proper decision of the committee. When the replies are all in, we would be pleased to print the names of all manufacturers who have responded favorably, that our readers may know how ready they are to accede to reasonable demands in the interest of purchasers, even though it involves temporary trouble and delay in their factories—and also of those who do not care to act upon such considerations.

Meanwhile, we propose to advocate the scheme of uniformity at every opportunity, and to do all in our power to further the efforts of the committee.

——o——

STRIÆ OF DIATOMS.—In Count Castracane's article upon this subject, referred to by Prof. Hamilton Smith on a preceding page, he states that in determining the number of striæ on a given portion of a frustule, he has made use of photography, which he considers as far more reliable than the method of counting by an eye-piece micrometer. He has made about 3,000 photographs of diatoms under the uniform magnification of 535 diameters. We are at a loss to understand his condemnation of the micrometer for this work—he strongly maintains that it is misleading but without giving the reason. He maintains, and supports his argument with what seems to be satisfactory evidence, that on all the frustules of any species upon which the markings are regularly arranged, "the fineness of the striæ is the same on valves of different dimensions, that is to say, that the fineness of the striæ is determined by the idiosyncracy of the species, and consequently * * * the striæ and their fineness are *a quality of specific importance.*"

THE BOSTON WATER-SUPPLY.—The water of Boston has lately been very disagreeable owing to the so-called "cucumber" taste and a peculiar odor, and, from the accounts in the newspapers, we judge the trouble has been of a very serious character. We are indebted to Mr. Bragdon, of Boston, for articles published in the papers of that city, which treat the subject at considerable length.

We have already published several articles treating of the odor and taste of the water supplied to cities, but, without undue repetition, we may now add a few words with special reference to the present trouble at Boston. It appears from the reports, that while the cause of the peculiar taste was generally ascribed to the decay of vegetable matter, there was much uncertainty as to the precise nature of the substance undergoing decomposition, and also as to the pond in which the contamination originated. We most heartily commend the systematic and thoroughly scientific manner in which Professor Ira Remsen undertook to discover the origin of the trouble. We have not space to devote to a lengthy abstract of Prof. Remsen's report—a brief summary of his results must, therefore, suffice.

The chemical examinations revealed the fact that those waters in which the cucumber taste was noticeable contained more albumenoid ammonia than those which were free from that taste, and also that as the taste became stronger the quantity of albumenoid ammonia was greater. Owing to oxidation at the surface of a pond, a marked increase in the quantity of nitrogenous matter was observed in specimens of water taken from increasing depths. However, the chemical analyses failed to indicate the source of the contamination. The report then continues as follows:—

Having failed by chemical means to determine whether the substance which causes the "cucumber taste" is at the bottom of the pond or not, I now under-

took a special examination of the bottom, and soon discovered facts which led me to think I was at last on the true scent. The mud when first filtered from the water has no odor, nor has the water which comes from it, and which, as the analyses show, contains a large amount of nitrogenous matter. This water, further, has not a trace of the "cucumber taste." The question at once suggested itself: Does this taste come from something situated on some other part of the bottom, or may it be developed by contact of the mud and bottom water with air? A thin layer was spread on ordinary filtering paper and allowed to lie for a time. In about half an hour an odor was emitted from this material, whereas, at first, as has already been stated, it had no odor whatever. The odor increased for a time, but afterward, in the course of about an hour, the odor disappeared entirely and did not reappear. The odor suggested somewhat that with which we are all familiar, but I could not positively identify the two. There is, then, evidently something in the bottom, and which, by contact with air, is capable of giving off an odor. An examination soon revealed the presence of green masses, varying in size from that of a pin-head to that of a pea. These were present in a considerable quantity, and, in allowing the vessels which contained the mud to stand quietly for a short time, the green masses rose to the surface of the mud.

At this point I consulted Prof. W. G. Farlow, of Harvard College, for the purpose of procuring an authoritative statement concerning the nature of this green substance. He at once identified the material as plants belonging to the Nostoc family. The Nostocs are known to give off a disagreeable odor when decaying, and they have been observed in a number of other cases of contaminated waters. I at once picked out some of the Nostocs, and exposed them to the air, expecting to get a much stronger odor than I had obtained from the mud; but, to my surprise, the odor did not appear at all readily, and did not suggest the cucumber odor; nor did it become at any time nearly as strong as that of the mud itself, exposed under exactly the same conditions. After examining the subject carefully, I feel confidence in stating that, whatever may be the properties of the nostocs found at the bottom of Farm Pond, these plants are not the cause of the "cucumber taste." They may possibly contribute something to the taste; though, in view of other observations made by Prof. Farlow, I think this improbable. Certainly they are not the prime cause.

This conclusion agrees with the statement of Prof. Farlow, already referred to on page 15 of the current volume of this JOURNAL, and it is of considerable importance; showing that the pig-pen odor and the cucumber taste originate in totally different causes.

Finally, an examination of the debris, collected on a screen at one of the effluent gates, led to the discovery of what is doubtless the cause of the cucumber taste—the decomposition of a fresh-water sponge. Once more quoting the report:—

I collected a considerable quantity of the substance and convinced myself that each piece picked up had this strong odor, and, further, that pieces of it were constantly being stopped by the screen. The other materials picked off the screen did not have any odor that was in the least striking. There is not the slightest doubt that this peculiar substance is the only thing thus far found in the pond which has an odor unquestionably like that of the "cucumber water," and this substance must be present in considerable quantity, or it would not have been found to the extent described above. Prof. Farlow, to whom I submitted it first, pronounced it to be a fresh-water sponge. Acting on this information, I at once took my specimens to Prof. Alpheus Hyatt, a recognized authority of the highest standing on the subject of sponges, as well as other subjects. He kindly examined them, and pronounced them to be sponges. He, too, was struck by the odor, and recognized the strong similarity between this odor and that of the "cucumber water." His remarks on the subject are herewith submitted:

[Copy.]

The specimen is that known as *Spongilla fluviatilis*. This sponge is common in all fresh-water ponds, and in certain places is very abundant. While living it has a very strong odor, which is increased by decomposition. Masses of it easily decompose, and are often found partly living and partly decayed. It occurs on muddy bottoms; and also grows on sticks and other hard substances. The odor of

the sponge shown me by Prof. Remsen is like that of the water, strongly intensified.

ALPHEUS HYATT.

We cannot extend this notice, although our personal interest in the subject inclines us to do so. It seems clear that Prof. Remsen has at last discovered the cause of the cucumber taste in the Boston water,—it now remains to devise a remedy for the trouble.

——o——

REPORT ON CROTON WATER.—Professor Elwyn Waller, Ph. D., chemist to the Health Department of this city, has made a valuable report embracing the results of weekly examinations of Croton water during the years 1876 and 1877. The chemical analyses are given in full for each week, in a table. In regard to the odors of Croton water, it appears from the report that, as early as the year 1859, Dr. Torrey was called upon to report upon the odor then observed for the first time. We have no doubt that the plants alluded to in his report were *Cœlosphœrium* and *Anabœna*, both of which have been very abundant this year. As the result of considerable correspondence, it has been found that more than sixty towns are occasionally more or less troubled by the odor of the water supplied to them, and the characteristics of the waters furnished them are briefly described in the report.

——o——

MR. BALEN'S LIVING SPECIMENS.—We need not apologize for inviting once more the attention of our readers to Mr. Balen's efforts to furnish living specimens of infusoria for study. He has at last decided to advertise his specimens, which will be furnished at a reasonable price, hoping to establish a small business in this way which will be of benefit to both himself and to those who subscribe for his collections. We take pleasure in saying that he has a remarkably rich field for collecting, near his residence in Plainfield, and such gatherings as we have seen have been well worth the prices asked for them. Societies would do well to order some tubes for exhibition at their meetings.

——o——

PRIZES.—The Boston Society of Natural History offers a first prize of from $60.00 to $100.00, and a second of $50.00, for the best memoirs in English on the following subjects:—

April, 1882.—The occurrence, microscopic structure, and use of North American fibre-plants. Treating especially of the fibres employed by the native races.

April, 1883.—Original unpublished investigations respecting the life-history of any animal.

CORRESPONDENCE.

TO THE EDITOR:—I have just made myself a parabolic illuminator, which, as it costs but a trifle, I think may be of interest to some of your readers.

Taking my 1½-inch objective (any other suitable power will do as well), I wound a clean copper wire of $\frac{1}{84}$-inch diameter closely around the base three times, twisting and bending the ends for a length sufficient to reach a little beyond the end of the objective. I then cut a section of about half an inch from the bowl of a new, plated teaspoon, and soldered the convex side to the ends of the wire, also making the loop solid with solder, and filing it up to a good fit and figure, so that it would slip easily on and off the objective. The objective was then focussed on a slide and the reflector adjusted, by bending the wire, until it gave very good results with parallel rays. Thus I have a handy and useful piece of apparatus, at the cost of the spoon, 30 cents. Mr. E. H. Griffith, of Fairport, N. Y., gave me the notion of utilizing a spoon for this purpose.

W. H. TIVY.

[After the above article was in type we received a communication from Mr. E. H. Griffith describing the same instrument, which, as Mr. Tivy states, is original with Mr. Griffith. We regret that his description did not reach us sooner, for we would then have printed it. Another article from Mr. Griffith will be printed next month, describing his method of making cells.—ED.]

TO THE EDITOR:—I see in the November number of your JOURNAL that, while throwing missiles at Prof. C. H. Stowell's new magazine, you give a glancing shot at "Grey Beard." Permit me to say in your JOURNAL, on behalf of the poor old man, "*Ne Jupiter quidem omnibus placet.*"

GEO. C. TAYLOR.

[The question is, whether a scientific journal is intended to please or to instruct. We have our own opinions regarding this subject, and, as a matter of principle, we shall still condemn Prof. Stowell's magazine until it is made more serious, dignified, and more creditable to American journalism.—ED.]

NOTES.

—Van Tiegham has observed Bacteria living and forming spores at temperatures as high as from sixty to seventy-four degrees C., although the highest limit for their growth has been stated as about fifty-five degrees C. The nutritive fluid used in these experiments was an infusion of beans; but Miquel has also described a filamentous *Bacillus* in water, which supported a temperature of seventy degrees. It should be noticed that at seventy degrees C. water is scalding hot.

—A letter from Mr. Eug. Mauler calls our attention to a misunderstanding which led us to state, on page 195, that he used a blue cover-glass to secure a monochromatic light. The cover-glass is of the ordinary kind, but a piece of ordinary thin blue glass is cemented to the slide, upon which the diatoms are mounted; thus the light is transmitted through the colored glass before it reaches the diatoms.

—*Our Little Ones* is a monthly magazine published by the Russell Publishing Company, of Boston, full of good, fresh, healthful stories for young people. The illustrations are excellent, well-drawn, and calculated to interest and amuse the children. The stories are instructive and not extravagant—which cannot be said of all the stories now published in juvenile magazines. It gives us pleasure to commend *Our Little Ones* as a suitable magazine for children to read.

—Dr. C. Seiler recommends as an imbedding mixture for cutting sections, a mixture of two parts of paraffin and one of mutton tallow. He states that this mixture will not shrink away from the tissues or from the wall of the well, as does paraffin alone.

—A number of orders for slides of adulterations have been received. None have been filled as yet, for the reason that the examinations of articles of food, mentioned some time ago, have been temporarily interrupted. However, the sets of specimens are nearly complete, and will be sent to subscribers as soon as they can be made ready.

—In the November number, in the article of Prof. Birge, on page 210, the word "titanus," on the fifth line, should be "tetanus." Prof. Birge is at the University of Wisconsin, not of Missouri.

—Mr. Vorce, of Cleveland, states that the water-bear *Macrobiotus*, one of the Tardigrada, has recently been found in the water-supply of that city, but, he adds, much to our surprise, that it seems not to have been mentioned in any microscopical journals published in this country from *The Lens* to the present time, and he infers that it is not common here.

We have frequently met with it in collections from various localities during the past three years, and we have a very distinct recollection of some experiments made some time ago. Having a good collection of water-bears, and knowing their remarkable power of reviving after being dried, we carefully prepared some specimens on slides, with the dirt and debris in which they lived, and allowed the water to evaporate spontaneously. After many days, when we wanted to exhibit our specimens, we moistened the dried mass on the glass, but no Tardigrada revived. Yet we have lately seen an account of some experiments which seemed to prove that these animals really do revive after dessiccation. We do not doubt the fact, but we do say that the conditions of dessiccation—perhaps the rapidity with which it takes place, or the nature of the debris which may sometimes prevent perfect drying—influences the result to some extent.

—A hornet's nest is said to be the best polisher in the world for glass lenses. But you want to do your polishing when the hornet is not around to help you. For what shall it profit a man if he polish a thousand glass lenses in a day and one hornet catch him at it.—*Burlington Hawkeye.*

MICROSCOPICAL SOCIETIES.

ILLINOIS STATE (CHICAGO).

The semi-annual meeting was held on Friday evening, October 28th, the President, Dr. Curtis, in the chair. Dr. Mercer described and exhibited a camera lucida by Nachet, of Paris, which differs considerably from those usually seen in this country. It is a square prism with its ends cut at an angle of about forty-five degrees. It is so mounted that one end is directly over the eye-lens of the ocular, and this end is provided with a smaller ninety degree prism, so mounted that the pencil of rays from the ocular passes directly upward to the eye without suffering any change of direction. The two forty-five degree faces of the prism serve to reflect an image of the pencil to the eye of the observer, thus reversing the performance of the ordinary camera, which changes the direction of the rays from the object under examination. Dr. Mercer thought the apparatus had some qualities which entitled it to consideration, the ease with which it could be used by an inexperienced person being a strong recommendation. In reply to Mr. Bullock, he stated that it could be used with as high as a two-thirds-inch ocular, possibly with one of still higher power.

Dr. Johnson exhibited a high-angled $\frac{1}{8}$ objective, made by Powell & Leland. Its balsam-angle was forty degrees, and the makers claimed that it would resolve the *Amphipleura pellucida* into beads. It had a good working-distance, and, although an oil-immersion, it could be used with glycerin and probably with water. It had a remarkably flat field and compared favorably with a Zeiss $\frac{1}{12}$ in his possession.

An immersion-condenser came with the objective. It is quite different from the ordinary high-angled condenser made by this firm, and consists of two systems of lenses, placed close together, the lower of which is very large, the upper very small. The pencil of rays, therefore, has a high angle of convergence, probably as much as one-hundred and fifty degrees for balsam. It is provided with a diaphgram with central and side apertures, the latter at an angle of ninety degrees. It has also a pin-hole aperture for centering.

A Powell & Leland cobweb micrometer was also exhibited by Dr. Johnson,

E. B. STUART, Secretary *pro tem.*

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Mounted slides of Selenites for the Polariscope, in most beautiful and brilliant colors, in exchange for first-class Histological and Pathological slides and slides of diatoms, algæ, etc.,
A. C. GOTTSCHALK,
193 North Salina Street, Syracuse, N. Y.

Unmounted objects, Foraminifera, Spicules, Zoophytes, etc., in exchange for other objects, mounted or unmounted. E. PINKNEY, Dixon, Ill.

Unmounted objects, Foraminifera, Spicules, Plant-hairs, Zoophytes, etc., in exchange for other objects, mounted or unmounted.
E. PINCKNEY, Dixon, Ill.

Wanted—First-class mounts of double-stain vegetable preparations in exchange for first-class insect preparations. H. S. WOODMAN,
P. O. Box 87, Brooklyn, E. D., N. Y.

Well-mounted Histological and Pathological slides in exchange for other first-class slides.
W. H. Bates, M.D., 184 Remsen St. Brooklyn, N. Y.

Wanted—first-class prepared and crude material, or mounted objects, in exchange for diatoms *in situ* or other first-class crude material, or for mounted objects.
M. A. BOOTH, Longmeadow, Mass.

Niagara River Filterings for mounted slides.
H. POOLE, Buffalo, N. Y.

Wanted—good gatherings of Diatoms, fossil or recent, especially of test forms. Liberal exchange in fine slides; prepared or rough material. Lists exchanged.
C. L. PETICOLAS, 635 8th Street, Richmond, Va.

Good, uncleaned Diatomaceous material containing *Arachnoidiscus, Heliopelta, Pleurosigma, Isthmia, Triceratium, Surirella gemma* and *Terpsinoœ musica* wanted, in exchange for well-mounted slides of arranged diatoms, etc., or cash.
DANIEL G. FORT, Oswego, N. Y.

Well-mounted Histological and Pathological slides, in exchange for other *first-class slides.*
LEWIS M. EASTMAN, M. D.,
349 Lexington Street, Baltimore, Md.

For exchange: Mounted thin sections of whalebone, soapstone, serpentine, albite, feldspar, etc.; also opaque mounts of several very beautiful fossiliferous limestones.
Rev. E. A. PERRY, Quincy, Mass.

Well-mounted, typical Pathological and injected Histological preparations, in exchange for other well-mounted slides, Diatoms, Algæ and Fungi preferred.
HENRY FROEHLING,
59 N. Charles Street, Baltimore, Md.

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